National Use Of Green Power

United States

U.S. involvement in green power basically began in the 1970's as a result of the oil embargo by the Organization of the Petroleum Exporting Countries (OPEC). The huge increase in the price of oil created seemingly endless lines at gas stations, and was partly to blame for the recession and inflation that besieged the nation at that time. In 1978, President Carter signed into law the National Energy Act of 1978 (NEA), a compendium of five bills that sought to decrease the Nation's dependence on foreign oil and increase domestic energy conservation and efficiency. One of these bills was the Public Utility Regulatory Policies Act of 1978 (PURPA). PURPA was the most significant section of the National Energy Act in fostering the development of facilities to generate electricity from green sources. PURPA opened the door to competition in the U.S. electricity supply market by requiring utilities to buy electricity from qualifying facilities (QFs). QFs were defined as non-utility facilities that produced electric power using cogeneration technology, or power plants no greater than 80 megawatts of capacity that use green power sources.[6]

PURPA is considered to be the primary contributor to the soaring renewable energy supply in the 1980s. At that time, electricity costs were rising and demand for growth was high, which led to favorably priced, long-term contracts for renewable generation. Since then the cost of green power has decreased, but expansion still has not occurred as quickly as previously expected. Energy price trends, including plunging oil prices and falling generating costs, can be blamed for impeding green power introduction.

Table 11: U.S. Non-utility Qualifying Facilities Producing Green Power (1998)

Fuel Source	Nameplate Capacity (MW)	Gross Generation (GWh)
Biomass	8,219	45,032
Geothermal	1,449	9,882
Wind	1,373	2,568
Solar Thermal	340	876
Photovoltaic	14	11
Total	**11,395**	**58,369**

Source: Energy Information Administration

In 1992, the federal government further enhanced utility involvement in green power with the Energy Policy Act of 1992 (EPACT). EPACT established a 10-year, 1.5 cents/kWh production tax credit for investor-owned wind projects and biomass plants using dedicated crops (closed-loop) brought on-line between 1994 and 1993, respectively, and June 30, 1999. In addition, EPACT instituted the Green Power Production Incentive, which provided a 1.5 cents/kWh incentive for generation from biomass (except municipal solid waste), geothermal (except dry steam), wind and solar from tax exempt publicly owned utilities and rural cooperatives.

[6] Energy Information Administration, *Renewable Energy 2000*

Table 12: U.S. Electric Power Sector Net Summer Capability, 1989-1999 (MWs)

Source	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Geothermal	2,603	2,669	2,632	2,910	2,978	3,006	2,968	2,893	2,853	2,917	2,898
Biomass	7,840	8,796	9,627	9,701	10,045	10,465	10,283	10,560	10,538	10,263	11,010
Wind	1,697	1,911	1,975	1,823	1,813	1,745	1,731	1,678	1,579	1,698	2,251
Solar/PV	264	339	323	339	340	333	333	333	334	365	374
Total	**12,404**	**13,715**	**14,557**	**14,773**	**15,176**	**15,549**	**15,315**	**15,464**	**15,304**	**15,243**	**16,533**

Source: Energy information Administration, *Renewable Energy March 2001*

Solar

The U.S. didn't really get involved with solar until after the oil crisis of the 1970s. In 1975, the U.S. government began a PV research and development project assigned to the Jet Propulsion Laboratory. Then, in 1977, the Solar Energy Research Institute, later known as the National Renewable Energy Laboratory (NREL), opened in Golden, Colorado. At this time, solar energy production was around 500 kW.

In 1979, Solenergy was founded. NASA's Lewis Research Center (LeRC) completed a 3.5-kW system on the Papago Indian Reservation in Schuchuli, Arizona; this was the world's first village PV system. NASA's LeRC completed an 1.8-kW array for AID, in Tangaye, Upper Volta, and later increased power output to 3.6 kW.

Utility scale solar power began coming to market in the 1980s. In 1983, ARCO Solar dedicated a 6 MW PV substation in central California in the Carrissa Plain. The 120 acre unmanned facility supplied the Pacific Gas and Electric Company utility grid. Also, in 1983, the first in a series of Solar Electric Generating Stations (SEGS) was installed, with output sold to Southern California Edison Company. SEGS I used solar trough technology to produce steam in a conventional steam turbine generator. In 1984, the Sacramento Municipal Utility District commissioned its first 1 MW PV generating facility.

PVUSA (Photovoltaics for Utility Systems Applications) was established as a partnership between public and private utilities, government agencies, and private companies who are involved in the photovoltaics industry. PVUSA was created in 1986 to further the use of photovoltaics as a commercially viable energy source, and to help utilities and PV industry vendors understand each other's way of doing business. The research and demonstration function ceased in May 2000. The PVUSA project was composed of more than two dozen utility-interconnected PV systems. These systems totaled over 2.3 MW of peak generating capacity and were installed at the main Davis, California test site and at nine other sites across the U.S.

U.S. demand for PV cells has since grown to 36 MW in 2001, and the U.S. is now producing 24% of the world's solar cells. However, about 70% of this production is exported. Recent years have seen rapid growth in the number of PV installations on buildings that are connected to the electricity grid. This area of demand has been stimulated in part by government subsidy programs and by green pricing policies of utilities or electricity service providers. The central driving force though comes from the desire of individuals or companies to obtain their electricity from a clean, non-polluting, renewable source for which they are prepared to pay a small premium. In these grid-connected systems, PV supplies electricity to the building and any day-time excess may be exported to the grid.[7]

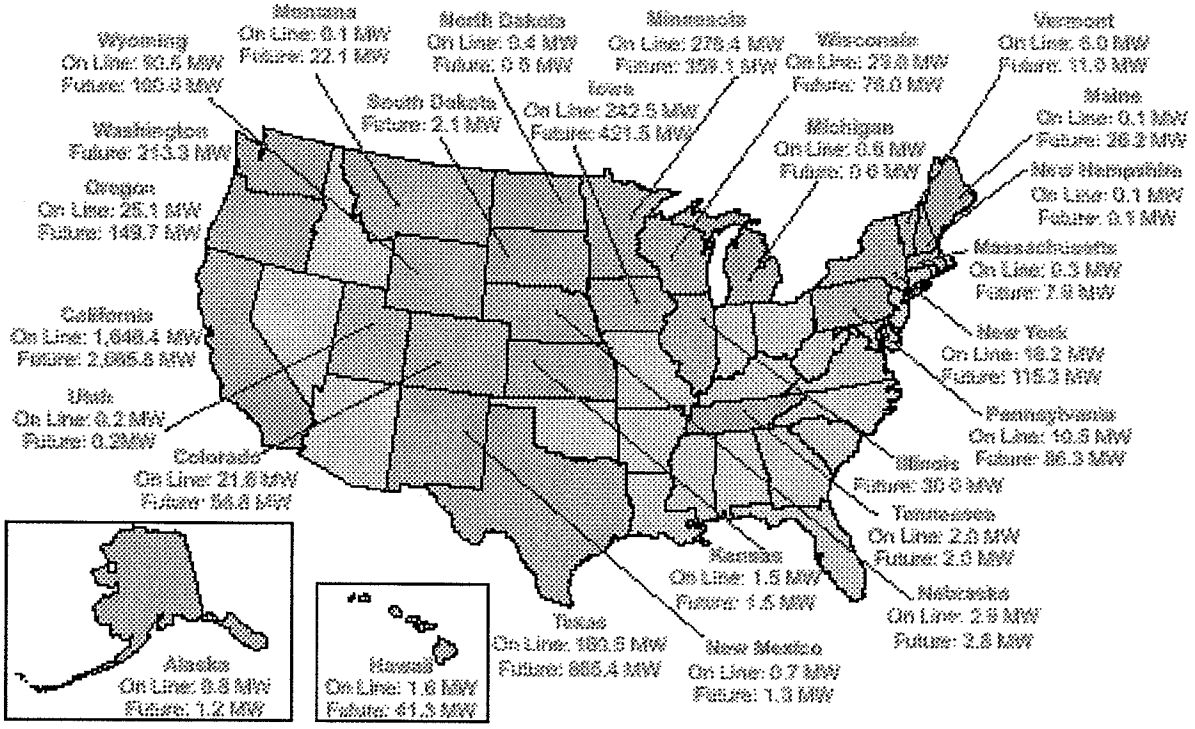
[7] SolarBuzz.

Wind

During the years 1973-1986, the commercial wind turbine market evolved from domestic and agricultural applications of small machines in the 1 to 25 kW size range to utility interconnected wind farm applications of intermediate-scale machines of 50 to 600 kW. Wind farms in California made up the majority of wind turbine installations until the early 1990s. In California, over 17,000 machines, ranging in output from 20 to 350 kW, were installed in wind farms between 1981 and 1990. At the height of development, these turbines had a collected rating of over 1,700 MW and produced over 3 million MWh of electricity.

In the 1990s, the California wind farm market began to be affected by the expiration or forced re-negotiation of attractive power purchase contracts with the major California utilities. Renewal was needed -- buoyed by green power initiatives in Colorado, Texas, and elsewhere -- U.S. wind energy development resumed in 1999, with a much broader geographical base. A variety of new wind projects were installed in the U.S. in the late '90s, including a cluster of turbines operated for a utility in southwest Texas, a wind farm of 46 machines planned for Big Spring, Texas, a 10 MW wind plant in Northern Colorado, a number of plants in the upper Midwest, and the "re-powering" of some projects in California. There's a sense that the wind industry is finally on the move again, with over 4,000 MW of new capacity proposed for 2003 in the U.S. alone.

Figure 32: U.S. Grid Connected Wind Power (as of 12/31/00)



Source: NREL

BioPower

In the United States, the period from 1973 to the present has shown a dramatic upswing in bioenergy use, especially in thermal and electrical applications of wood residues. The wood processing and pulp and paper sectors became about 70% self sufficient in energy in this period; and the amount of grid-connected electrical capacity has increased from less than 200 MW in 1978 to more than 7,000 MW.

In 1984, Burlington Electric in Vermont was the first to build a 50 MW wood-fired plant with electricity generation as the primary purpose. This plant started a new trend. In 1985, the biomass power industry began to grow in California where 850 MW of BioPower was added. By 1990, electricity generated from biomass reached 6 gigawatts.

With more than 7,000 MW of installed capacity, biomass is the second-most utilized renewable power generation resource in the U.S. The 37 billion kWh of electricity produced each year from biomass is more than the entire state of Colorado uses annually. Generating this amount of electricity requires around 60 million tons of biomass per year.

The biomass power industry is mainly located in the Northeast, Southeast, and West Coast regions, representing a $15 billion investment and 66,000 jobs. Three states, California, Maine and Michigan, provide 55% of the biomass sales generation capacity. The average size of a sales generation BioPower plant is 18.5 MW. More than 70% of biomass power is cogenerated with process heat. Wood-fired systems account for 88%, landfill gas 8%, agricultural waste 3%, and anaerobic digesters 1%. There are nearly 1000 wood-fired plants in the U.S., typically ranging from 10 to 25 MW.

Woody biomass is concentrated in the Southeast, Northeast, Pacific Northwest, and Upper Great Lakes regions. Herbaceous/grassy biomass is plentiful in the Midwest states, while cropland is concentrated in the upper Midwest, Lower Great Lakes region, and Mississippi delta. Research is currently underway to improve energy crops that are well-suited to regional climate conditions throughout the U.S.

Geothermal

In 1960, the country's first large-scale geothermal electricity generating power plant began operation for Pacific Gas and Electric. The first turbine produced 11 MW of net power and operated successfully for more than 30 years. Today, over 2,228 MW of installed geothermal generating capacity exists in the U.S.[8]

Research performed by the Idaho National Engineering and Environmental Laboratory (INEEL) has found that Nevada holds the largest amount of untapped geothermal resources in the U.S., with a potential of 2,500 to 3,700 MW of electricity. Wells and springs exist over the entire state, offering extensive opportunities for development of low- and high- temperature resources for direct use or power generation. Currently, Nevada is one of the top producers of geothermal power with 235 MW installed capacity. Geothermal energy provides about 9% of northern Nevada's electricity with 14 power plants operating at 10 geothermal sites.

Idaho and New Mexico also have enormous geothermal resources that have barely been tapped. Idaho already has 70 direct-use geothermal sites, but they have the resources to provide up to 20% of Idaho's power needs. New Mexico is currently a leader in using geothermal energy for space heating, however they only have one geothermal electric power

[8] International Geothermal Association.

plant, a 500 kW binary unit that supplies electricity to a large geothermally heated greenhouse. Geologists have identified several other prospective sites in the Jemez Mountains and in the north-central part of the state that could support more than 20 MW of power.[9]

Ocean Power

In 1980, the U.S. Department of Energy (DOE) built OTEC-1, a test site for closed-cycle OTEC heat exchangers installed on board a converted U.S. Navy tanker. Test results identified methods for designing commercial-scale heat exchangers and demonstrated that OTEC systems can operate from slowly moving ships with little effect on the marine environment. A new design for suspended cold-water pipes was validated at that test site.

At Hawaii's Seacoast Test Facility, which was established as a joint project of the State of Hawaii and DOE, desalinated water was produced by using the open-cycle process. And a 1-meter-diameter cold-seawater/0.7-meter-diameter warm-seawater supply system was deployed at the Seacoast Test Facility to demonstrate how large polyethylene cold-water pipes can be used in an OTEC system.

Later, tests by the U.S. DOE determined that aluminum alloy can be used in place of more expensive titanium to make large heat exchangers for OTEC systems. And at-sea tests by DOE demonstrated that biofouling and corrosion of heat exchangers can be controlled. Biofouling does not appear to be a problem in cold seawater systems. In warm seawater systems, it can be controlled with a small amount of intermittent chlorination.

In May 1993, an open-cycle OTEC plant at Keahole Point, Hawaii, produced 50,000 watts of electricity during a net power-producing experiment. Today, scientists are developing new, cost-effective, state-of-the-art turbines for open-cycle OTEC systems. [10]

[9] Idaho National Engineering and Environmental Laboratory. 30 April 2002.
[10] National Renewable Energy Laboratory.

Canada

Hydroelectric energy is the main source of electricity in Canada, representing nearly two-thirds of all electricity produced. Most of this hydroelectricity comes from large projects developed by electric utilities. The largest producers of electricity in the country are provincially-owned electric utilities such as Hydro-Quebec, BC Hydro, Newfoundland and Labrador Hydro, and Manitoba Hydro. About one-tenth of the electricity is exported to the United States, either as firm or interruptible electricity. Furthermore, significant revenues are generated from project planning, turbine and other equipment manufacturing and project construction, in both Canadian and export markets.

The availability of possible sites for small-scale hydroelectric facilities are numerous. The current capacity of all small hydroelectric facilities in Canada is about 2000 MW. Natural Resources Canada has completed an inventory of Canadian small hydroelectric sites. It identified over 3600 sites with a technically feasible potential of about 9000 MW. However, only about 15 per cent of that total, approximately 1300 MW, would be economically feasible with current socioeconomic conditions and technologies. If capital costs could be reduced by 10 to 15 percent, which should be achievable with future technological improvements, an additional 1800 MW of economically exploitable capacity would be available. Over the last decade, the small-scale hydroelectric industry has contributed about $100M per year to the Canadian economy in manufacturing and services.

Today, 5.9% of Canada's primary energy demand is supplied from the combustion of biomass. Other countries that are not heavily industrialized or do not have indigenous fossil fuels still use biomass for a large portion of their energy supply.

Canada is blessed with vast amounts of biomass, much of which remains unused. Canada has vast forests, but extensive studies have shown that only a small percentage of that forest growth is harvested for forest products. Nutrient balance experiments have shown that forest residuals could be removed for fuel without adversely affecting the forest ecosystem. In fact, residuals must be removed in some forests to allow replanting of productive tree species. Furthermore, some of the harvested logs are not used for traditional products. They could be used as fuel for generating energy for mills. In the late 1800's significant land areas in Canada were cleared and converted to subsistence farming despite the poor quality of the soils. Now that modern agriculture provides a food surplus, these areas are no longer farmed. These areas could be used to grow fast-growing tree crops or high-yielding perennial grasses to be used for biopower. Another potentially significant resource of biomass is municipal solid wastes. Of the millions of tons produced per year in Canada, only a small percentage is used for energy. Unfortunately, most of Canada's municipal solid wastes and forest residuals go to landfills or are incinerated.[11]

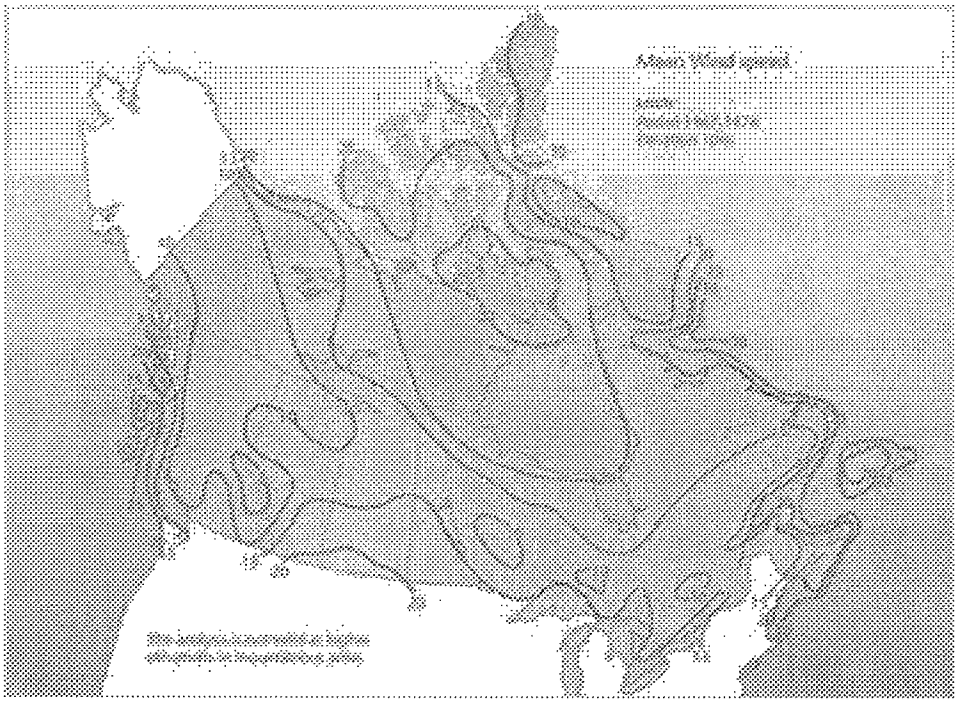
Testing is being done with geothermal energy in Canada, but it is not being generated commercially so far. There is a test geothermal site in the Meager Mountain - Pebble Creek area of British Columbia. A 100 MW electrical facility might be developed at that site after further testing.

Canadian use of wind energy has been slow because of its low electricity prices, and because the country generates more electricity than it can use. Nevertheless, several wind turbine manufacturers have representatives in Canada. There is also a major company in Ontario that produces wind turbine blades up to 37m long for European and US manufacturers. The map

[11] Canadian Renewable Energy Network.

below shows that Canada has extensive wind energy resources and that the best areas for wind turbines are in the Gaspésie, Maritimes, Southern Alberta and Saskatchewan, and the far North. However, wind speed is strongly affected by local terrain, so favorable wind speeds can be found in most areas of Canada.

Figure 33: Average Annual Wind Speeds In Canada



Source: Canadian Renewable Energy Network

Europe

Austria

Austria's energy supply is based on a balanced mixture of energy sources, which is characterized by the prominent role of renewable energy. Its share in the overall energy system has been rising continuously since the mid-seventies and reached 26.4% of total energy supply in 1996. This rate is one of the highest in the European Union. The reasons for this positive development are that renewable energy has been a long-term priority of Austria's energy, subsidy and research policies for years. Plus, the Austrian people have a high level of environmental consciousness and have supported the idea of utilizing renewable energy sources from the beginning.

Table 13: Austria Use Of Renewable Energy

	1990	1991	1992	1993	1994	1995	1996
RES Primary Energy Production (ktoe[12])	5775	5616	5872	6433	6196	6614	6208
RES Contribution To Total Inland Consumption (%)	25.7	27.0	25.5	25.6	26.3	26.7	27.6

Source: EnR Renewable Energy Working Group

Forest makes up about 46% of Austria's landscape. It is among the most densely wooded countries in Europe. Therefore, it makes sense that over 70% of Austria's biomass is generated in low-temperature applications like the combustion of wood or wood chips is single heaters or central heating boilers for small scale users. Nearly one-third of the annual overall biomass supply of about 150 PJ[13] is used for process heat and in industrial CHP plants.

A new fluid bed process for the gasification of biomass has been developed which will allow the production of high-grade product gas. In order to provide a suitable technology for the low and medium power range (200 kW to 1 MW), researchers at Graz Technical University are developing a solid bed gasifier. Specifically, this process could be implemented in biomass-fired district heating networks to supply their own power demand.

Currently, there are about 200 BioPower installations of different sizes and types in operation. Besides several smaller installations, the gas from Vienna's largest landfill at Rautenweg has been recovered for energy production since 1991. This plant with an electric power capacity of 8 MW and an annual electricity production of about 40 GWh is currently the largest in Europe.

Three Municipal Solid Waste (MSW) incineration plants are in operation in Austria. Two of them are located in Vienna. Their annual capacity is about 438,000 tons of MSW. About half of the MSW's heat value derives from various biogenous materials. The Spittelau-plant produced 35 GWh of electricity and 442 GWh of heat in 1997.

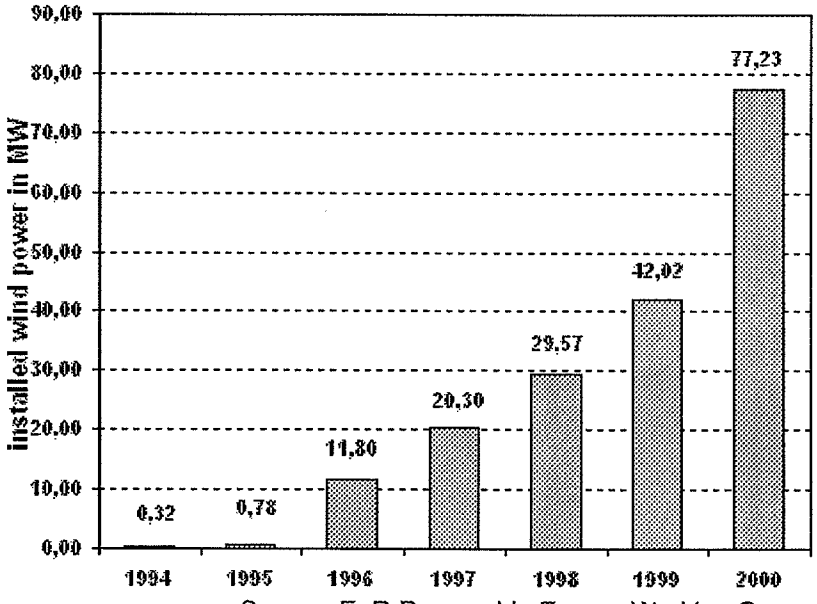
Austria has become a leader in wind energy among landlocked countries, but it wasn't until just a few years ago that large installations were built. In 1993, the first major grid-connected wind power station came on line. By the end of 1997, as many as 52 installations representing an

[12] ktoe = equivalent to one thousand tons of oil = 4.5 GWh
[13] Petajoule (PJ) = 277.778 GWh = 0.9478×10^{12} btu

overall rated capacity of 20.3 MW were operating, producing approximately 32 GWh per year. By the end of 2000, a total capacity for wind power of nearly 19,000 MW had been installed.

Several problems must be taken into account in the future development of Austria's wind power potential. In a landlocked country, wind speeds are lower than in coastal regions, and wind incidence and, consequently, power output are subject to considerable fluctuation. This discontinuous supply necessitates energy reserves from other sources. Furthermore, there are issues of landscape protection to be considered in connection with any further exploitation of wind power. If these problems can be worked out, conditions for wind power are particularly favorable in the agricultural areas in the foothills of the Alps in the Federal States of Salzburg, Upper Austria and Lower Austria, as well as in the regions of Mühlviertel, Waldviertel and Weinviertel, in the northern part of the Federal State of Burgenland and in parts of southern

Figure 34: Wind Energy In Austria (MW)



Source: EnR Renewable Energy Working Group

Lower Austria and of the neighboring Federal State of Styria. Finally, the often windy capital, Vienna, would also be a suitable location.

The first megawatt photovoltaics facility in Austria was not established until 20 years after the introduction of this form of energy in the 1970s, the second took another three years and the third 1.5 years (1999), illustrating the increase in the rate of installation. By the end of 1996 installations generating a total of 1,739 kW (peak) were operating. About 51% of these are grid-connected, 26% are self-supporting, so-called "insular" installations, and the remaining 23 % run various small appliances. Assuming an annual power output of 700 kWh per kW (peak) installed (i.e. the mean value of self-supporting and grid-connected installations), the current contribution of photovoltaics to power production in Austria is about 1,200 MWh per year.

Geothermal energy in Austria got its start by accident. In 1978, while drilling for petroleum near Bad Waltersdorf in eastern Styria, the prospectors struck a hot spring. In 1981, the local council, who had immediately begun to look for possible applications for the thermal water, decided to employ it to heat the local school, a kindergarten and an outdoor swimming pool.

Later, a thermal spa was built and heated with thermal energy. Today the spring heats hotels with a total capacity of 1,000 beds, two schools and a thermal spa including a therapy center.

Six geothermal installations have been built to date, the best-known of which is the 10 MW plant at Altheim in upper Austria. Several more projects are in the planning stage, some of them supported by the THERMIE program due to their innovative character. During the last few years the annual growth rate was constantly around 30%.[14]

Under current economic and geological conditions, Austria's total geothermal potential amounts to about 7 MW. The construction of 20 to 40 plants is considered realistic. Geologically suitable areas include the so-called Styrian thermal spring region, the Upper and Lower Austrian molasse basin, and the Vienna basin. Some of these regions, however, are rather sparsely populated, which makes such operations less economical. Six geothermal installations have been built to date, the best-known of which is the 10 MW plant at Altheim in upper Austria. Several more projects are in the planning stage.

Denmark

During the 1960s only municipal solid waste was a major source of green power in Denmark. As in most other European countries the promotion of other sources of green power was spurred by the oil crisis in 1973. During the 1980's the energy policy increasingly emphasized economic sustainability and saved foreign currency from declining imports of fossil fuels. A biomass-based program for combined heat and power (CHP) was initiated in the latter half of the 1980's. Joint projects between the Danish Energy Agency and the utility companies were carried out to prepare the expanded use of land-based turbines.

In 1993, utility companies were required by the government to use biomass, replacing 6% of the total consumption of coal with straw and wood. In 1996, the Danish government endorsed the present energy strategy, *Energy 21* which reinforced the governments aim to reduce the national CO_2 emission by 20% by 2005 and by 50% by 2030 as compared to the 1988 level. On March 1999 a large majority of the Danish Parliament entered into an agreement on a comprehensive electricity reform. Part of the Agreement concerns green power. A mandatory target of doubling the share of green power to 20% by 2003 was adopted. According to the indicative target in *Energy 21*, the share of green power (including hydro) is targeted at 66% by 2030. [15]

Wind energy also gained in importance during the 1980s and Denmark has subsequently become a major force in wind turbine manufacturing. Sales from the Danish wind industry broke all previous records in 2001, selling 3,452 MW. This was a 60% increase compared to 2000. In 2001, the Danish manufacturers sold twice as much wind energy capacity as the global sales of new nuclear capacity. The Danish manufacturers have experienced an average annual growth of 37% in wind turbine sales over the last five years.

Denmark actually experienced the first decline in installations since 1993. The wind power capacity installed in Denmark dropped to pre-1995 levels. Only 77 MW were installed in 2001 compared to 566 MW in 2000. However, this huge decline was expected. In 1999, the Danish Parliament decided to introduce a green certificate market. The result was a sudden uncertainty of future payment conditions and this caused a boom in wind turbine sales in 1999 and 2000

[14] EnR Renewable Energy Working Group, *Renewable Energy in the EU and Norway*
[15] Ole Odgaard, *Renewable Energy in Denmark*

before the old payment system expired. By the end of 2001, almost 6,500 wind turbines were installed in Denmark with a total capacity of 2,500 MW, which exceeded Denmark's wind energy targets. Therefore, only a few wind turbine sites are still available in the regional plans made by the local authorities. Furthermore, a new Danish payment system still needs to be introduced as the continued uncertainty of future payment conditions makes it difficult for potential wind turbine investors to finance new wind turbines. In the future, new wind installations are expected to take place offshore and by replacing old, small wind turbines with big, modern turbines.

Table 14: Production of Green Power (Terajoules)[16]

Source	1980	1988	1990	1996	1997	1998
Solar	50	61	105	259	280	300
Wind	38	1,050	2,197	4,417	6,963	10,005
Geothermal	-	-	48	32	50	54
Biogas	184	354	752	1,990	2,394	2,670
Biomass	25,143	41,832	44,453	61,094	61,106	60,158
Total	**25,415**	**43,297**	**47,555**	**67,792**	**70,793**	**73,187**

Source: Ole Odgaard, *Renewable Energy in Denmark*

The first geothermal plant in Denmark was established in connection with the district heating supply in Thisted in 1984. The subterranean structure of Denmark contains geological structures which contain hot water. This can be utilized for district heating production, either directly or via absorption heat pumps or electric heat pumps. In 1996 the Danish Energy Authority set up a working group to study the potential for increased utilization of geothermal energy in Denmark.

Denmark is trying to repeat its success with the development of wind generators by developing competitive wave generators. The Danish Wave Energy Program was initiated in order to develop economic and reliable ways of converting wave energy. During the first two years of the program the interest in wave energy grew, and about 40 new ideas for how to harness ocean power around Denmark were built into models and tested. The final objective is to find a few well-documented machines or hybrid machines that can lead to the commercial development of wind energy. As of 2000, they had found the oscillating water column prototype like the Mighty Whale in Japan, was the most expensive. The least expensive system was the oscillating water column system called Swan DK3. The difference in cost and performance was a result of further development of the oscillating water column principle by changing the geometry of the ducts and the floating structure and proposing concrete for hull construction rather than steel. Denmark hopes to perfect wave energy technology, and believes that where there are technologically with wave energy systems is similar to where they were 20 years ago with wind energy systems.

Interest in photovoltaics is increasing in Denmark, though the price per kWh is still considered too high for it to really catch on. The price needs to be reduced considerably for PV to compete with other renewable energy sources.

[16] 1 Terajoule (TJ) = 277.778 MWh = 0.9478×10^9 btu

Finland

Finland's share of green power in energy consumption is among the highest in Europe. BioPower accounted for 20% of Finland's energy supply in 2000. Within industry, biopower represents about half of the fuel consumed.

The use of biopower has been promoted since the 1970s. Most of the biomass based energy production in Finland originates from CHP plants. The most important biopower sources are the forest industry's black liquors and wood residues, as well as firewood. Finland is the world leader in the development of biomass combustion technology and the manufacture of fluidized bed boilers that are suitable for burning different kinds of biomass. The advantages offered by fluidized bed technology include high efficiency and low emissions. Technological advances and changes in energy taxation have helped biopower become more competitive. For example, efficient wood production chains which extend from the forests to the power plant have made biopower more competitive.

Solar and wind energy are being developed in Finland. Wind energy development is focusing on arctic wind energy. The weather conditions in Lapland place special technical constraints on wind power generation. The biggest problem is that ice builds up on wind turbines in arctic regions. The first arctic wind farm in Finland was built in 1996 with two 450 kW units. A 65 kW turbine was erected at Paljasselkä as a first attempt to test turbine operation at site subject to icing. A de-icing system was installed in 1994, and the turbine continues to be an ongoing part of research. Another arctic turbine was installed in 1993, and it has been operating commercially since 1998. Finland has made many changes and alterations to standard wind turbines to make them economically viable in their cold climate. The first offshore wind power plant was erected in 1998.

The erection of wind turbines in Finland is presently small. By the end of 1999 a total of 38 MW installed capacity produced 49.1GWh -- less than 1% of the total electricity consumption of the country. The price of wind generated electricity has decreased by 30% during 1990's to approximately 0.25 FIM/kWh (0.042 Euro/kWh).

In the first half of the 1990s, two separate national programs were created for the enhancement of renewable energy sources, one dealing with biomass and the other one with wind energy. The bioenergy promotion program launched in 1994 aimed at increasing bioenergy consumption by 1.5 Mtoe[17] that is by 25%, until 2005 in comparison to the 1992 situation. The goal of the national wind energy program was to erect a total of 100 MW capacity in Finland until 2005.[18]

Extensive research was done on photovoltaics in Finland in the 1990s. This research has provided a strong technical base for commercializing PV systems and launching them into new, growing markets. The development work has included thin-film facades for buildings, which offer a 30% cost reduction from the crystalline silicon technology. They have also done work on developing hydrogen-based energy storage techniques for the long-term storage of solar energy. A small number of grid connected solar power demonstration projects have been carried out, the most important being an 30 kW array owned by Fortum in Kopparnäs.

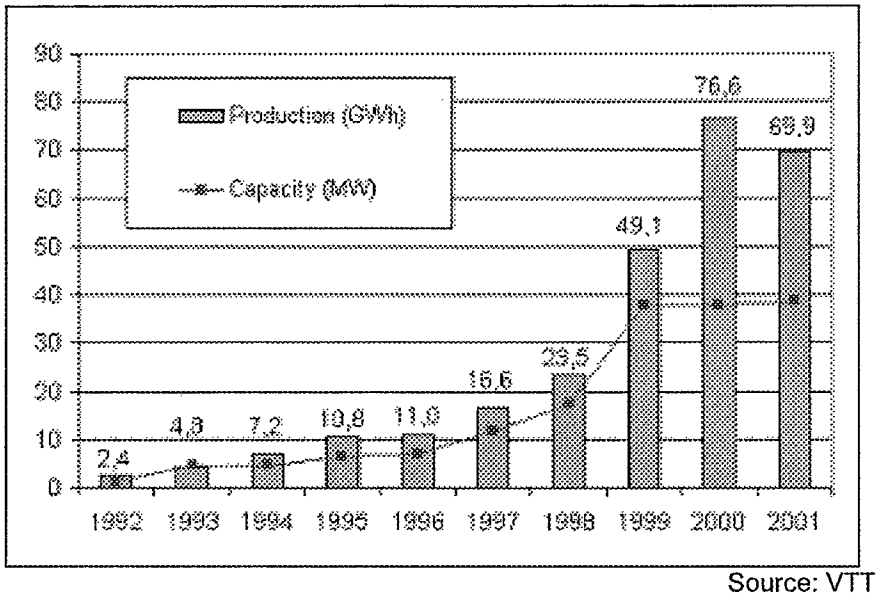
In Finland, the total capacity of hydropower is 3,000 MW producing 12.6 TWh in 1999 (16.2% of Finnish electricity production). A major share of this capacity stems from large-scale hydropower

[17] Mtoe = equivalent to one million tons of oil = 4.5 TWh

[18] EnR Renewable Energy Working Group, *Renewable Energy in the EU and Norway*

plants, however approximately 10% of the total capacity is from the 200 operating small-scale hydropower plants.

Figure 35: Wind Power In Finland



Source: VTT Energy

Germany

Germany has approximately 280,000 green energy customers, and many large German companies are buying green power, helping to create consumer demand to move beyond fossil fuels.

The most dynamic development in green power in Germany has been in the field of wind energy. Between 1990 and 1999, the installed capacity of wind power increased from 60 MW to 4,445 MW generated from 7,879 wind turbines. Today there is over 8,000 MW of installed capacity. This is mainly due to the guaranteed tariffs for electricity set by the Electricity Feed-In Law. A major federal investment support program for wind energy started in 1989. It provided grants for the operation of wind turbines up to 0.08 DM/kWh to a maximum of 25% of total investment costs. Extensive work in research and development in the field of wind energy was funded by the Federal Minister for Research and Technology. More than 300 million DM (153.39 million EURO) have been spent in this field since 1980.

Germany is now considering plans to build up to 5,000 wind turbines off of Germany's north coast. Some would be located in open sea up to 27 miles offshore. Since the wind is stronger at sea, there is good potential for wind energy. Giant wind turbines, double the size of conventional turbines, are being developed for this type of offshore use.

The German solar industry exploded in 2000. Deutcher Fachverband Solarenergie (DFS), the German Association for Solar Energy, reported a 50% rise in solar panel orders in 2000. German solar companies sold 75,000 solar systems in 2000 in addition to 360,000 solar systems installed previously, and PV installations increased fourfold in 1999. The solar industry just kept growing in 2001. Some 20,000 solar energy systems yielding an output of about 77 MW were installed, almost twice as many as in 2000. With these additions, the total solar electricity capacity in Germany is now estimated at over 170 MW. The largest grid-connected

PV system in Germany is a 1.75 MW plant in the Bavarian municipality of Sonnen. However, this plant won't be the largest for long since there is another system planned for 5 MW, which will not only be Germany's but also Europe's biggest PV system.

Due to a lack of natural steam reservoirs, geothermal energy cannot be converted into electric power at competitive prices in Germany at present. Successful development of the Hot Dry Rock (HDR) technology could change this situation. The principle of HDR technology is to circulate a fluid between an injection well and a production well, along pathways formed by fractures in hot rocks. A deep heat exchanger is then created, and the fluid transfers heat to the surface, where it can be converted to electricity.

Table 15: German Green Power Statistics

Population	82,264,000 (2001)
Renewable energy production	34.1 TWh (2000)
Green energy customers	280,000 (2001, est)
Green energy sales	690 mln kWh (2001, est)

In Germany, there are high feed-in rates (guaranteed electricity prices) for biopower. Utilities such as EnBW, MVV and RWE-owned Harpen are all active in this sector. In some parts of Germany there is a shortage of getting wood fuel because it has all been contracted out to biomass plant developers. It will be even worse in the future. Shell entered this market recently but they had to pull out because they couldn't get enough fuel at low enough prices. Most electricity from biomass in Germany is produced using combustion plant coupled with a steam turbine.

Greece

Greece's natural resources of sunlight and wind put the country in an excellent position to develop and exploit renewable energy as sources of heat and power. However, the development of green power technology didn't really become an issue in Greece until the Energy Crises of the 1970s. So far, the only catalyst for green power in Greece has been legislation. When Greece officially became a member of the European Community in 1980, significant changes in energy policy had to be made. Until then Greece's energy policy had primarily focused on the promotion of energy saving measures and ensuring supply. During the 1980s, legislation was passed on certain aspects of green power development, such as the exploitation of geothermal potential. More importantly, legislation was pass that allowed third parties to produce a limited amount of electrical power from biomass, wind, solar, hydro, and ocean energy. Essentially, production was limited to the satisfaction of producer's needs and any surplus energy could be sold to the Public Power Corporation (PPC) only, not to third parties. The result was that green power still accounted for only a very small proportion of the total and was not a priority for national energy policy.

During the 1990s, two more significant measures were passed to reinforce efforts to promote the penetration of green power in Greece. The first of such measures, established the "Operational Program for Energy," as well as set the terms and conditions under which third parties could generate green power. Production by self-generators and independent producers was raised to 50 MW, and the tariffs for the purchase of this electricity were defined as a proportion of the PPC's selling prices.

The Operational Program for Energy, financially supported by the European Union and the Greek Government, provided direct grants for both high cost and low cost energy investments. The Renewable Energy Subprogram of the Operational Program for Energy (1994-1999) was the main funding mechanism for green power installations and expired in 1999. The program had a total budget of 340 MEuro and supported not only green power investments, but also broad "infrastructure" work, such as the development of the National Certification System, the assessment of technically exploitable green power potential, and the determination of the optimum administrative and legislative framework for green power.[19]

Despite this legislation, green power in Greece has not reached its potential. For example, while Greece's many hours of sunshine lend themselves to solar energy production, this is presently only exploited for heating water. PV systems are still quite expensive. As technology improves over the next five to ten years costs are expected to decrease, which will open up new opportunities for solar power.

Wind energy is also a promising resource in Greece. The islands offer ideal conditions for the generation of wind power, and wind systems are less expensive than solar power systems. Wind farms, which have a total installed capacity of 110 MW, have been developed on the island of Crete, which is isolated from the mainland electricity grid. Wind installations are also appearing on other islands, and studies have shown that the Aegean Islands have ideal conditions for wind energy. According to the PPC, such installations could generate up to 30% of the Aegean islands' energy requirements, a ten-fold increase on current capacity. Private investors are beginning to take advantage of the financial incentives provided by the Greek government and the EU for the setting up of wind-driven power generators. The Center for Renewable Energy Sources (CRES) estimates that 15% of Greece's electricity needs can be produced by wind farms, with installed wind power capacity increasing from 270 MW at present to 2,000 MW by 2010.

Perhaps the most interesting development in the coming years will be in the field of geothermal energy. Scientists are just beginning to explore the potential of natural sources of hot water for energy production and Greece has several sites that are suitable, including on Milos and Nisyros and in Northern Greece. At present the use of geothermal energy is limited to district heating plants and agricultural purposes, such as greenhouses; it has not been used for electricity generation. If it could be, then those natural forces historically linked in Greece with destruction, in the form of earthquakes and volcanoes, could come to provide environmentally friendly energy solutions.

Ireland

Northern Ireland has the potential for the utilization of a number of renewable energy sources ranging from biopower, agricultural and municipal wastes, hydro power, wind, solar and wave power. However, by 1995 only 0.11% of energy used within Northern Ireland came from

[19] Altener Programme, *Final Report of the Ener-lure Project, RES legislation in Greece*

renewable sources. The main mechanism to increase the uptake of renewable energy production within Northern Ireland comes from The Non-Fossil Fuel Obligation (NFFO) which has set targets of at least 3% of Northern Irelands total energy consumption by 2005 originating from a renewable sources, by 2005. Approximately 2% of electricity produced within the UK comes from a renewable energy sources. The Government has set a target of 5% by 2005 and 10% by 2010. These targets will be met through both, future large-scale renewable developments but also by smaller scale projects on domestic properties, schools and other similar premises.

Green power is small in Ireland and comes mostly from wind farms and landfill gas plants. Ireland has one of the best wind resources in the world. Every county in Ireland has at least one location called "Windmill hill" or "Windmill Lane." The first commercial wind farm of 6.45 MW was commissioned and supplying electricity to the electricity grid in 1992. By Sept. 2001, there were 22 wind farms, with over 150 turbines, operating in Ireland with a total installed capacity of 125 MW. In the summer of 2001, the government announced a scheme called the AER V Program, to get an additional capacity of 240 MW built by 2003. The most recent results from this program, announced in Feb. 2002, allocated Power Purchase Agreements to approximately 355 MW of wind energy. In Jan. 2002, Ireland's Minister for Natural Resources announced plans for a £640 million offshore wind farm to be built in the Irish Sea.

Table 16: Wind Farms Developed in Ireland

Site	Location	Installed MW
Bellacorrick	Co. Mayo	6.25
Barnesmore	Co. Donegal	15
Altagowlan	Co. Roscommon	1.2
Ballybofey	Co. Donegal	15
Tullymurray	Co. Roscommon	4.8
Kilronan	Co. Roscommon	5
Cronalaght	Co. Donegal	4.8
Drumlough Hill	Co. Donegal	4.8
Crockahenny	Co. Donegal	5
Inverin	Co. Galway	2.64
Currabwee	Co. Cork	4.62
Cronalaght II	Co. Donegal	1.98
Millane Hill	**Co. Cork**	**5.94**
Tralee	**Co. Kerry**	**15.18**
Beenageeha	**Co. Kerry**	**3.96**
Ballybunion	**Co. Kerry**	**16.5**
Fuinneamh Geoithe Teo	**Co. na Gaillimhe**	**2.8**
Castlebar	**Co. Mayo**	**2**
Edmondstown	**Co. Roscommon**	**4.8**
Belemaguire	**Co. Leitrim**	**3.4**
Ballyconnell	**Co. Caven**	**3**

Anarget Upper	Co. Donegal	19.8
Cuilliagh Mountain	Co. Donegal	11.88
Newtownstewart	Co. Tyrone	5
Strabane	Co. Tyrone	5
Derrylin	Co. Fermanagh	5
Limavady	Co. Derry	5
Clogh Mills	Co. Antrim	1
Clogh Mills	Co. Antrim	5
Ballyclare	Co. Antrim	5
Fivemiletown	Co. Tyrone	5.9
		197.25

Source: Irish Energy Centre

In Ireland the most feasible and best-developed biofuels are short rotation willow coppice and woody residues from forestry. The development of this form of renewable energy has also been aided as it offers a solution to some of the problems faced by the agricultural sector. As demand for traditional crops wanes, measures such as the Common Agricultural Policy put the onus on alternative land uses by the farming community. The growth of wood such as willow fulfils this need. The most innovative use of wood currently being developed in Northern Ireland is small-scale gasification technology, which converts wood chips into electricity and heat.

Low temperature geothermal energy is typical in Ireland and can be tapped into using a heat pump. The Irish people use this geothermal energy for space and water heating, but unfortunately they aren't able to use it for generating electricity.

Geothermal energy is not in use in Ireland at this time. The geothermal aquifer resource in Ireland is located mostly around sandstone basins such as those under Larne and Ballycastle. These resources are not however suitable for exploitation using technology available today.

Low temperature geothermal energy is typical in Ireland and can be tapped using heat pump technology. Ground source heat pumps use a small amount of energy to collect and concentrate heat stored in the ground to provide space and water heating, or to dispel heat for air conditioning.

Studies have found that the main accessible resource of tidal energy within Ireland is in the region of Carlingford and Strangford Loughs. If these resources were to be exploited an estimated 800 GWh/year of electricity could be produced. It is however doubtful that these sites would be economically viable for exploitation due to the small tidal range. There are also several environmental concerns surrounding the development of tidal power at these sites.[20]

Italy

In Italy, the share of energy generated by green power is currently about 22% of domestic yearly production. For the most part, this energy is generated by hydroelectric and geothermal plants. For several years now, the Italian government has been taking an interest in other renewable energy sources like wind, solar and biomass energy with the intent of increasing

[20] Irish Energy Centre. Renewable Energy Information Office.

diversification, securing supply, improving the balance of trade, safeguarding the environment, and opening up new opportunities for employment and social development.

As far as wind energy is concerned, in the past the Ministry of Industry, Commerce and Trade (MICA) coordinated a number of research and demonstration programs. One of the most effective measures so far has been Directive No. 6 issued by the International Committee for Prices (CIP) on April 29, 1992. This Directive allowed premium prices to be paid for electricity generated from green power. This created an incentive among private investors, who presented MICA with a large number of wind farm projects. By the end of 2000, Italy had invested in 427 MW of wind energy. This includes a 170 MW wind farm located in southern Italy. In a joint project, Italian Vento Power Corp. and Japanese trading company Tomen, Corp. built the wind farm and electricity from the facility is sold to the Italian state utility ENEL.[21]

The first geothermal power generation plant was constructed in 1904 in Larderello, Italy. This had a capacity of 250kW and used geothermal steam to generate electricity. This plant has proven geothermal energy plant's long-term sustainability. Today, there are over 760 MW of geothermal energy plants installed in Italy.

The Italian Parliament first began to legislate on green power in 1982, with efficiency and renewable energy sources Law 308. The legislation established the basis for public regulations and financial incentives for energy. Additional laws passed in 1991 and 1992 obliged ENEL (the National Electricity Board) to purchase electricity from and fixed premium prices for producers of green power. Out of this law 3,700 MW of green power production were installed by the end of 1995. Italy then went into a period of overcapacity, so the Ministry of Industry blocked the 1992 law in July 1996. In 1998, responsibility over green power was transferred from the Ministry of Industry to Regional Administrations.[22]

Norway

Hydropower accounts for more than 99% of the electricity production in Norway. Norway also has 13 MW of installed wind capacity on ten wind farms on the Norwegian coast, producing approximately 35 GWh/year.[23]

Wind energy is thought to be the perfect complement to hydro power in Norway because the dams could function as storage for the wind energy. It is estimated that wind energy could generate 480 terrawatt-hours of electricity each year in Norway, and double that level if lower speed wind resources were used. However, Norway's environmental movement has recently been split by state owned utility Statkraft's plans to develop three wind farms with a total production of 800 MW along the scenic west coast. Some nongovernmental organizations have expressed either serious concern or outright opposition to the idea of building wind farms in this location. Their concerns are that the wind farms would have an adverse impact on tourism. By the end of 2001, Norway's wind potential had barely been tapped with only 17 MW of wind energy having been installed at that time. Norway is hoping to reach their goal of producing 3 terrawatt hours per year of wind energy by 2010.

After hydropower, biopower is the most significant contributor to current renewable energy supply in Norway. The main types of biofuels in Norway are firewood, wood chips, wood

[21] American Wind Energy Association.
[22] Altener Programme, *Final Report of the Ener-lure Project, RES legislation in Italy*
[23] EnR Renewable Energy Working Group, *Renewable Energy in the EU and Norway*

briquettes, and wood pellets. The national policy is to increase biopower energy 4 TWh by 2010. Currently biopower accounts for about 5% of Norway's energy consumption at 13 TWh.

Norway has no specific goal directed at introducing solar energy to a greater extent in the Norwegian energy system. Solar energy projects will be considered by Enova, the Norwegian agency for promoting energy savings, along with other energy projects within the framework of a long-term and environmentally friendly shift in the energy system.

Portugal

Portugal is a small energy market with around ten million inhabitants and has the lowest energy consumption per capita in the European Union. Portugal has a good renewable energy potential, but relatively low penetration. The current penetration is split between hydro, wind and traditional biomass. There is also some penetration of solar technologies.

Since 1978, Portugal has played an important role in wave energy development. Most of the research on wave energy conversion has been devoted to oscillating water columns (OWC). Plans to construct a full-size wave energy plant on the island of Pico in the Azores were initiated in 1986. This led to the development of a 400 kW shoreline OWC, which was completed in 2000 and expected to be commissioned in March 2001. Besides being a pilot facility for research, the plant will supply 8-9% of the island's demand for electricity for the next 25 years.

The limited geothermal resources in mainland Portugal have been developed for direct use, whereas geothermal resources in the Azores are utilized for the production of electricity. There are about 50 natural occurrences spread throughout the mainland and twelve areas with potential for developing geothermal electricity generation have been identified on the islands in the Azores. Currently, there are 3 power stations on the island of São Miguel. A 3 MW pilot plant was built in 1980 in the northern part of the island. This was followed by a 5 MW plant, and an 8 MW plant. However, the Portuguese World Energy Council Member Committee reports an end-1999 installed capacity of 20 MW. These is an estimated potential of 80 MW in the Ribeira Grande field. Therefore, it is predicted that an additional 25-30 MW of capacity could be constructed by 2010, thereby meeting 40-45% of the electrical demand of the island.[24]

The Portugal Government is interested in increasing the use of renewable energy technologies to decrease their dependency on fossil fuel imports. In 1988, Decree-Law 189 came into force, defining the rules for the independent production of electricity from green power. In parallel, the licensing procedure to use water for electricity generation was clearly established by legislation. Both regulations were responsible for the small-hydro market boom in the early 1990's, but the last few years saw the construction of few new plants. Predominantly in the North and Centre Regions of Portugal, the 170 MW small-hydro installed capacity generates about 600 GWh/yr. However, the potential for expansion is estimated at above 500 MW.

By the end of 2000, about 100 MW of electricity-generating wind turbines were operating in Portugal. This figure was up from 64.5 MW in 1999. At that time, 57.5 MW were on the Mainland and 6.9 MW were installed in the Regions of Madeira and Azores. Three new 750 kW wind turbines installed in Serra de Laze in Portugal helped boost those numbers.

The PV total installed capacity in 1997 was about 530 kW. Most of the PV systems are stand-alone systems. R&D and grid-connected installations represented 6% of the total capacity. In

[24] World Energy Council. 2002.

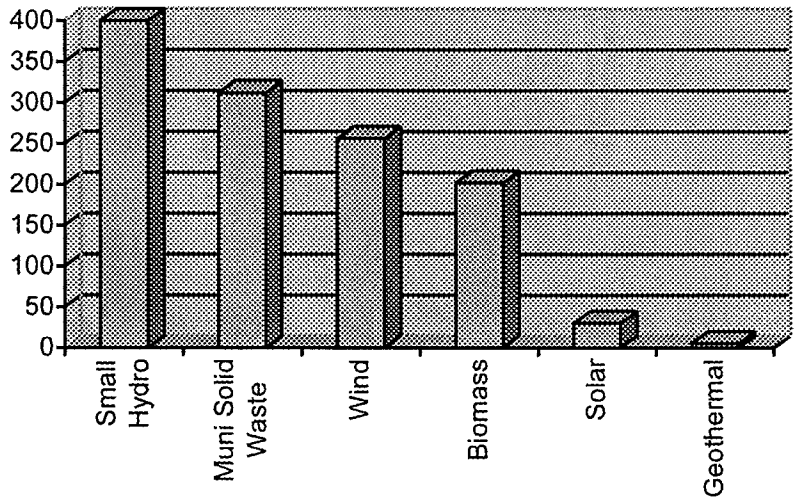
1994, the first PV system (10 kW) linked to the electricity grid was mounted on the roof of a building owned by the national power utility. The first PV-wind hybrid system (40 kW) was installed in 2000 to provide electric power to 5 rural communities in the South of Portugal.

Spain

In late 1994, Royal Decree 2366 was passed which formulated basic criteria to govern relations between the owners of green power plants and the electricity utilities in Spain, with a view to achieving the following objectives: a) to develop a framework to clarify the future of such production in the context of energy planning criteria and priorities; b) to deal with different forms of energy as appropriate; c) to improve information and follow-up systems for energy planning.

In 1998, Royal Decree 2818 was passed which establishes a mechanism for annual adjustment of premiums for energy production at plants using renewable energy sources or resources, waste and cogeneration.

Figure 36: Green Power Sources In Spain, 1999 (ktoe)



Source: Altener Programme

As at the end of 1999, there was an installed capacity for small hydro of 1,541 MW in Spain, distributed among the 1,045 small hydropower stations in operation. More than half of these have also been refurbished, modernizing or building a new plant, in the last 13 years, so they have technologically advanced equipment.

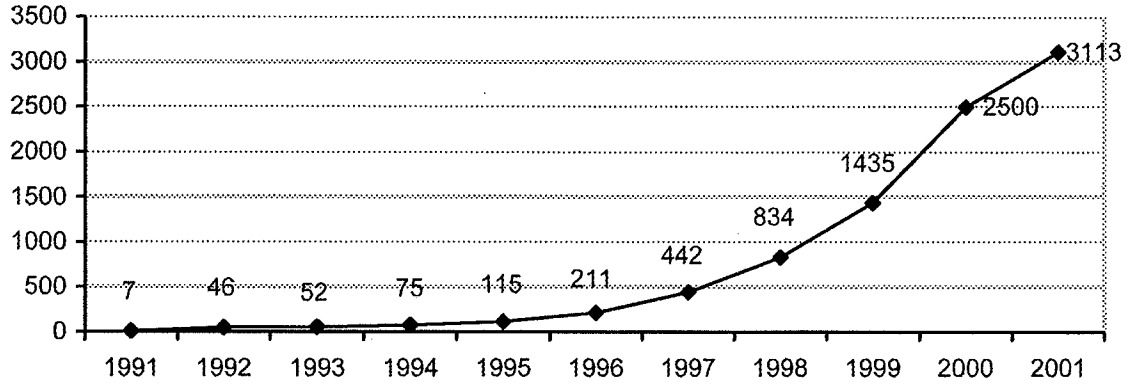
The use of biomass for electricity totaled 202 ktoe in 1999. During 1999, 14.6 MW of new capacity using biomass was installed in Spain, bringing the total capacity of plants using this source to 202 MW. In 1999 electricity generation from biomass (including biogas) accounted for 0.6% of the total gross national electricity generation and 13% of the total electricity generation using renewables, excluding large hydro. Of the 6 new projects started up during 1999, approximately 5 MW of new capacity corresponds to biogas plants.

Biomass has historically played a major part in the energy supply of Spain. Over 14.3 million tons of municipal solid waste are produced yearly in Spain. At the end of 1990, four MSW incineration plants were operating in the country with energy recovery: San Adrián de Besós, Montcada and Tarragona in Catalonia and EMAYA in the Balearic Islands. With the exception

of the EMAYA plant, they remain in operation today. In 1994, construction of the Maresme-Mataró plant was completed by the Maresme MSW Treatment Consortium, made up of 27 municipal districts. This plant has a complete gas emission treatment system. Its electricity generating capacity is 11.1 MW. In 1996, plants were completed in Melilla (2.7 MW) and Palma de Mallorca (22.7 MW). The total installed capacity for electricity generation across the incineration plants operating in Spain in 1999 amounts to 94.1 MW, with 660 GWh as average annual output. The foreseen incineration capacity incorporating energy recovery in year 2001 amounts to 1,544,000 MSW equivalent tons per year. The National Waste Plan contemplated an energy valuation of urban waste of 9% by the year 2001 (compared to 4% in 1996).

Spain is a country with excellent wind resources and a well-developed technology in the wind energy field. This technology is a result of the active participation of Spanish industry in research and development. The strategy followed for the development of wind energy in Spain has been implemented in several steps. From 1980 to 1985, the program focused on assessing national resources and developing the technology. From 1985 to 1990, resource assessment and demonstration programs were launched with the installation of several small wind farms. Between 1990 and 1995, Royal Law of 2366 was published stating that utilities had to pay for the electricity from the wind power plants. Since, the wind power market in Spain has boomed. Spain now ranks second among European countries generating wind power with an installed capacity of some 2,500 MW. Spain has even surpassed wind power pioneer Denmark. In 2001, Spain installed 713 MW of new wind energy capacity.

Figure 37: Wind Power Capacity In Spain (MW)



Source: Altener

Solar energy technology has been slow to catch on in Spain, despite the fact that Spain's sunshine is a well-known natural resource. Ignorance and excessive bureaucracy appear to be hampering development. To date, Spain produces only 12 MW of solar energy and most installations are small rather than larger ones connected to the national grid. Solar energy premiums and other incentives are under review in Spain to create an attractive market opportunity, providing the economic incentives needed to reduce the initial high cost and risk of commercializing a new technology.

Despite this slow development, a couple of projects are currently in the works. On July 31, 2002, it was announced that new municipal facilities in the city of Gijón would have PV panels fitted to diminish their energy consumption. 406 solar panels will be installed in a total of ten public buildings, contributing 65 kW of power. Another Spanish project, called "Solar Tres" or

Solar Three, will use all the proven molten-salt technology of Solar Two, scaled up by a factor of three. Although Solar Two was a demonstration project, Solar Tres will be operated by industry as a long-term power production project. This utility-scale solar power could be a major source of clean energy worldwide, offsetting as much as 4 million metric tons of carbon through 2010.[25]

Sweden

For a long time the Swedish government has been favorable to using green power. As a matter of fact, Sweden has paved the way for other countries to open their doors to the benefits of green energy. Sweden initially agreed to phase out all their nuclear power plants and replace them with green energy by 2010. However, that target was abandoned in 1997 after officials acknowledged that the availability of sufficient renewable energy resources was insufficient.

Currently, production of renewable energy in Sweden is at six TWh. This amount accounts for 25.4% of the primary energy supply, one of the highest rates in the European Union. The main renewable contributions come from hydropower and biomass. In 1998, electricity from hydropower amounted to 76 TWh. This is 48% of the country's electricity production. During 1998, use of biomass amounted to 92 TWh. Bio-fuels now meet more than 50% of the supply to the district heating grids. CHP stations in district heating networks delivered 5.1 TWh of electricity during 1998. Industrial CHP stations supplied 4.5 TWh.

The electricity supplied by wind power during 1998 amounted to 0.3 TWh, which represents a 50% increase on 1997. Wind power accounted for 0.19% of total electricity generated in the country during 1998. At the end of 1998 there were 421 wind power units with an installed capacity of 174 MW.[26] In March 2002, a wind power company called Eurowind AB, announced plans to build a 200 turbine offshore wind farm in the southern Baltic Sea. Eurowind expects to complete this project by 2007.

Sweden has made a commitment to increase green power production to 16 TWh within the next eight years. They've also stipulated that a certain amount of all electricity bought by consumers must come from solar, wind, or biomass.

The Netherlands

Currently, only 3% of Dutch energy comes from renewable energy sources. This is mainly due to the fact that the flat landscape and the small area of the country offers little scope for hydropower and forestry, so most green power is biomass/biogas.

Biomass in the Netherlands mainly consists of waste streams, such as wood, GFT, verge grass and waste from the food industry like cocoa husks or potato peelings. These fuels are diverse in composition and origin, which makes it difficult to convert biomass into electricity. Also, some of these fuels are seasonal, which means that the use of biomass for energy generation has to be carefully controlled.

Despite these difficulties, biomass is the most prevalent green power in the Netherlands. In 1997, landfill gas was extracted from 44 sites. At 32 of these the gas is utilized for energy applications that prevent the use of 2.4 PJ/year of fossil fuels. The total installed power capacity is 30 MW. In 2000, waste incineration was performed at 11 municipal plants. These have an

[25] Solarbuzz.

[26] Altener Programme, *Final Report of the Ener-lure Project, RES legislation in Sweden*

installed capacity of 404 MW and prevent the use of 27 PJ/year of fossil fuels. The application of anaerobic digestion of organic sludge at waste water treatment plant is common in the Netherlands. At more than 120 plant anaerobic digestion takes place producing biogas that prevent the use of 2.1 PJ/year of fossil fuels.

For a nation known for its mastery of the wind in the eighteenth century, modern wind technology got off to a slow start. However, wind energy has finally begun to grow after being hindered for nearly a decade by misguided government programs. In 2002, there are 1349 wind turbines with a total capacity of 534 MW. The electricity generated was approximately 1100.4 GWh.[27]

Table 17: The Netherlands Green Power By Source (PJ)

Energy Source	1990	1995	1996	1997	1998
Wind	0.5	2.9	4.0	3.9	5.4
Solar PV	0.0	0.01	0.01	0.02	0.03
Hydro	0.8	0.8	0.7	0.8	0.8
Biomass/Waste	23.9	28.9	35.7	26.3	27.2
TOTAL	**25.2**	**32.61**	**40.41**	**31.02**	**33.43**

Source: EnR Renewable Energy Working Group
(Note: classification of green power changed in 1997)

The introduction of solar electricity systems in the Netherlands started at the end of the 1980s with stand-alone systems. From 1995 onward more and more grid-connected systems were installed. The potential for solar electricity in the Netherlands lies in the grid-connected systems. Not only newly built houses but also existing buildings are equipped with solar electricity systems. To cover the total electricity demand a surface of 800 square km is necessary which is available as roof surface on dwellings and buildings. The total PV capacity that existed as of the end of 1999 was about 4 MW stand-alone and 1.3 MW grid-connected for a total of 5.3 MW.[28]

Despite the small share that green power has in the total electricity supply, the Netherlands was the first country to offer consumers the option to buy green power. The Dutch government has set a goal of meeting 10% of its primary energy demand from renewable energy sources by 2020. This would make 17% of energy production from green power. There is also a short-term goal of a 9% increase by 2004.[29]

United Kingdom

The Electricity Act of 1989 empowered the Secretary of State to require utilities in England and Wales secure a specified amount of generating capacity from non-fossil fuels and for a levy to be placed on electricity customers to meet additional costs involved. This Non-Fossil Fuel Obligation (NFFO) has been used to stimulate the market and industry to assist green power become competitive in the longer term without further support.

Green power technologies in the UK are now establishing themselves as viable, credible contributors to energy supplies. They already meet nearly 3% of the UK's total electricity needs.

[27] Wind Service Holland. 13 August 2002.
[28] ECOFYS.
[29] Rottink, JBH. Infopoint Renewable Energy. Caddet Renewable Energy. Jan. 2002.

Some 933.6 MW of green power capacity from Non-Fossil Fuel Obligation (NFFO) Orders 1–5, Scottish Renewable Orders (SRO) 1–3 and Northern Ireland Orders (NI-NFFO) 1–2 are currently operational. Total electricity generation from green power in 2000 amounted to 10,237 GWh (2.8% of total), 50 percent of which was from large scale hydro generation.

Table 18: UK Green Power Capacity (MW)

	Contracted Projects		Commissioned Projects	
	Number	Capacity (MW DNC)	Number	Capacity (MW DNC)
Biomass	32	256.0	9	113.1
Hydro (small-scale)	146	95.4	65	42.4
Landfill gas	329	699.7	190	401.2
Municipal and industrial waste	90	1,398.2	17	205.3
Sewage gas	31	33.9	24	25.0
Wave	3	2.0	1	0.2
Wind	302	1,153.7	79	190.1
Total	**933**	**3,638.9**	**385**	**977.3**

Source: RESTATS

The fifth Non-Fossil Fuel Obligation represented the biggest and cheapest order to date. A record 261 projects were contracted under the Order with a capacity of 1,177MW of electricity. Furthermore, with the low cost of most of the near-market technologies supported, an average price of 2.71p/kWh for the latest Order was just off the competitive market price.[30]

Table 19: UK Potential Above Market Cost Of Green Power

Financial Year	Above Market Cost of Green Power (£Millions)
1998/99	130
1999/00	80
2000/01	110
2001/02	130
2002/03	145

[30] UK DTI, *New & Renewable Energy Prospects For The 21st Century*

00224

2003/04	150
2004/05	150
2005/06	150
2006/07	150
2007/08	150
2008/09	150
2009/10	150
2010/11	150
2011/12	150
2012/13	80

Source: U.K. Department of Trade and Industry

In 2001, the percentage of renewable energy showed continued growth. The percentage of UK electricity sales that were of electricity generated from sources eligible for the renewable obligation rose from 1.18 per cent in 1999 to 1.33 per cent in 2000 and 1.56 per cent in 2001. However, the percentage of UK electricity consumption accounted for by green power increased from 2.51 per cent in 1999 to 2.55 per cent in 2000 but fell to 2.43 per cent in 2001. The main reason for this fall was the reduction in the supply from large-scale hydro schemes, which are included under the EU renewables directive, because of the low level of precipitation.

Australia

Until the 1990s, green power (excluding large hydro) was only implemented in isolated instances, in insignificant amounts, and with mixed results. In 1998, the first large-scale grid connected wind farm was built in Crookwell, NSW, Australia. It was a 4.8 MW wind farm which actually doubled the installed capacity of wind energy in Australia at that time.

While Australia is still a long way from generating enough green energy to satisfy demand, renewable energy is a rapid growth industry. As of January 2002, over 988 MW of new green power had been proposed. That includes 211 MW of new solar power, 669 MW of new wind power, 48 MW of ocean power, and 60 MW of new BioPower.

Currently, Australia's green power sales are evenly divided between 60,000 residential customers and almost 2,500 commercial customers. Most of the green energy supplied to date in Australia is derived from biomass and hydroelectric power, with only 8 percent coming from wind or solar. With wind resource development accelerating; however, wind's share is increasing rapidly. In fact the Australian Wind Energy Association has set a target for 2002 that 100 MW of installed capacity of wind energy will be connected to the national electricity grid.

For the 2000-2001 financial year, green power sales to customers reached close to 470 GWh, which was ten times more than the amount sold in 1997. More consumers are choosing green power products and retailers are embracing this tiny market. The Sustainable Energy Industry Association, expects green power sales for 2001-02 to be over 500 GWh.

As a result of the growing demand for green power, over 100 new approved renewable energy projects have been installed in Australia since 1997, including the southern hemisphere's largest solar farm at Singleton, NSW and wind farms at Crookwell and Blayney in NSW, Codrington, Victoria and Ravenshoe, Queensland. Growth in the industry and the installation of new generators such as these are having a positive impact on employment and tourism in regional areas.

Table 20: Australia's Green Power Capacity

Green Power Technology	Current Installed Capacity	Proposed Capacity
BioPower	512,118 kW	60,020 kW
Geothermal	150 kW	--
Ocean	--	48,320 kW
Solar	2,011 kW	211,680 kW
Wind	105,977 kW	668,950 kW

The above table shows how quickly Australia's green power industry is growing. The number of homes in Australia choosing green power increased by more than 30% in the past year, with a green-conscious public driving the change. The Sustainable Energy Development Authority's national audit of accredited programs found the amount of green power used by participating households had jumped from 290,355 MWh in 1999-2000 to 454,505 MWh in 2000-2001.[31]

[31] Peatling, Stephanie. "Power Boom as Homes Switch to Green Energy." The Sydney Morning Herald. 17 July 2002.

The Australian Greenhouse Office has set a goal for the creation of a guaranteed market for approximately 9,000 GWh of additional renewable energy by 2010. This goal would increase the share of renewable energy in Australia's energy mix from 10.7 percent in 1997 to 12.7 by 2010.

Government Policies In Support Of Green Power

Most governmental support of green power has been driven first by energy security concerns (i.e., the oil crises of the 1970's) and then by environmental concerns (i.e., Kyoto). In response, most governments have set specific green power targets.

In order to meet these targets, there are a variety of incentives for the production of green power used throughout the world. These incentives include price support mechanisms, financial incentives/subsidies, tax incentives, tax exemptions, guaranteed sale of electricity to the national grid, and green certificates. Some countries have also sought to reduce administrative and technical barriers such as planning rules and arrangements for access to electricity grids and have introduced targeted information campaigns aimed at developers and the public.

The different mechanisms can be grouped under four headings as follows:

- Premium payments for green power,
- Direct capital grant support, subsidizing the investment in a green power source,
- Financial and tax incentives to lower the cost of finance,
- Research, development, and demonstration programs.

Primary support mechanisms for green power are those that most actively seek to reduce market distortions. Internalizing the external costs associated with fossil- and nuclear-based electricity generation is the most direct means by which this can be carried out but for a number of reasons this has not yet been achieved.[32]

Different primary support mechanisms exist in each country and can be grouped into competitive bidding, feed in tariff, and green credit trading.

In competitive bidding, the Government sets a target for the amount of green power capacity to be commissioned within a certain timeframe. Developers then enter a competitive process to get their project approved. The projects with the lowest per kWh prices (that meet all other requirements) are then selected. The oldest primary market mechanism is the Green Power Feed-In Tariff. With these tariffs, utilities are obligated to purchase electricity from green power plants at a guaranteed price. The newest type of primary support mechanism is green credit trading, introduced for the first time in The Netherlands at the start of 1998. In this, the government sets a "green credit" requirement for each energy distributor (similar to a renewable portfolio standard). Then, each kWh of electricity is sold at a market price. In addition, however, the generator receives from the utility a label or credit for every unit sold. These credits, which represent the perceived added value to society of the green power are then bought and sold in a secondary market by distributors to meet their requirement.

There are also a number of secondary support mechanisms governments use to encourage green power development. The most frequent of which is a direct capital grant support. Second, financial and tax incentives which take a number of forms but usually include accelerated depreciation, tax credits, and tax exemptions (from energy/CO_2 taxes). Finally,

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[32] Commissioner Ritt Bjerregaard, *Environmental Tax Reform.* at IPPR conference Environmental Tax Reform in Europe, Brussels, October 27, 1997.

research, development, and demonstration programs have been one of the most widespread means of encouraging green power development.

United States

The U.S. is one of the few industrialized nations that chose not to participate in the Kyoto Protocol. Therefore, no specific target for reducing CO_2 emissions or increasing the use of green power has been set. In spite of this, the U.S. has been very active in supporting green power.

The U.S. has set up the Office of Energy Efficiency and Renewable Energy (EERE) to guide the research, development, and deployment of green power. EERE has a goal for 25,000 MW of green power to be installed by 2010. It has several major green power initiatives, including "Wind Powering America" which establishes partnerships between public and private organizations to encourage the increased use of wind energy. This initiative has set a goal of providing 5 percent of the Nation's electricity from wind by 2020, with the federal government setting the example by obtaining 5 percent of its electricity from wind energy by 2010. In June 1999, there were 8 states with 20 or more MW of installed wind capacity. One of the initiative's goals was to increase this number to 16 by 2005 and to 24 by 2010. By the end of 2001, the number of states with more than 20 MW installed capacity was at 13.

Another initiative is "GeoPowering the West" which will link public and private sector efforts to bring geothermal electricity and geothermal heat to widespread portions of the West. The short-term goal is to double the number of States with geothermal electric power facilities to 8 by 2006. They also want to reduce the levelized cost of generating geothermal power to 3¢-5¢/kWh by 2007. These short-term goals will make it easier to reach their long-term goal, which is to supply at least 10 percent of the electricity needs of the West by 2020 with 20,000 megawatts of geothermal energy of capacity.

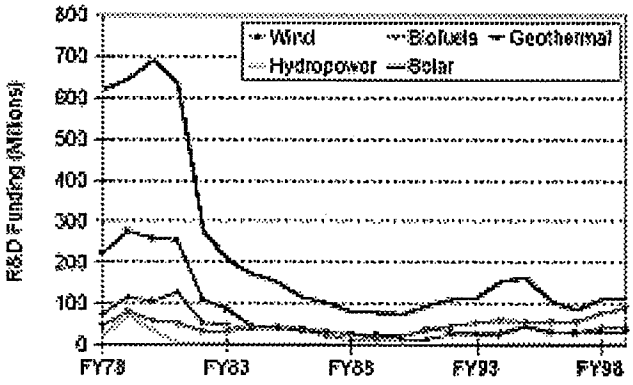
Table 21: U.S. EERE Green Power Budget ($ Millions)

Program	2001 Appropriation	2002 Appropriation	2002 Request
Solar Buildings	3.9	4.7	12.0
Photovoltaics	74.3	71.6	73.7
Concentrating Solar	13.5	13.2	1.9
Biomass Power	39.3	39.2	33.0
Wind	39.1	38.6	44.0
REPI	4.0	3.8	4.0
RE Program Support	4.0	2.8	2.1
International RE	5.0	2.8	6.5
Geothermal	26.6	27.3	26.5
Hydrogen	26.6	29.2	39.9
Hydropower	4.9	5.0	7.5
Renewable Indian	6.6	2.8	8.3
TOTAL	**247.8**	**241.0**	**259.4**

Source: EERE

The government also helped drive utility involvement in green power through funding research and development. Most of this funding has come from the Department of Energy (DOE) which provides two types of funding: cost-sharing and in-kind contributions. Cost sharing refers to project funding contributions by all parties involved in the project. In-kind contributions refer primarily to, on the company side, the payment of salaries and the use of equipment and resources during the course of work on the project, and on the government side, the use of capital equipment, such as scientific and engineering equipment and facilities at DOE's national laboratories.

Figure 38: U.S. R&D Funding For Green Power (1999 Dollars)



Source: Energy Information Administration

In June 2001, Secretary of Energy Spencer Abraham announced that the DOE, 48 states, three territories and the District of Columbia will combine resources to provide $40 million for 164 energy efficiency and renewable energy projects. The department is providing $17.5 million in funding through its State Energy Program special projects competitive grants. Though project-by-project details are yet to be determined, the states and their partners will provide approximately $22.5 million in additional funds through cost-sharing agreements. State Energy Offices will use these funds to improve the energy efficiency of schools, homes and other buildings, promote energy-efficient industrial and transportation technologies, and support green power sources such as solar, wind, geothermal and biomass.

An incentive program that already exists on the national level is the Renewable Energy Production Incentive (REPI). REPI provides financial incentive payments for electricity generated and sold by new qualifying green power facilities. Eligible production facilities are those owned by state and local government entities and not-for-profit electric cooperatives that start operations between Oct. 1, 1993 and Sept. 30, 2002. These facilities are eligible for annual incentive payments for 1.5¢/kWh for the first 10 years of their operation. Qualifying facilities must use solar, wind, geothermal or biomass technologies.

The main driver affecting green power installation in the U.S. has been state legislative and regulatory policies. Currently, 15 states have adopted System Benefit Charges (SBC) and 12 states have instituted Renewable Portfolio Standards (RPS). The SBC is a fee placed on customer's electricity bills. Almost every state that has passed electric industry restructuring legislation has used SBC to support renewable energy, energy efficiency, low-income customer programs, or other functions that the competitive market is unlikely to provide on its own. RPS mandate that a certain portion of power come from green sources. Additionally, a number of states are studying both of these options for future adoption. The rules and guidelines in each

state differ in the details.[33] And, there are states that have provisions for both funds and standards. Many states also include rules for the type and characteristics of the information that will be disclosed as consumers select their electricity provider.[34]

Renewable Portfolio Standards

A number of states have either adopted or are in the process of adopting an RPS. As part of restructuring their electricity industries, Arizona, Connecticut, Maine, Massachusetts, Nevada, New Jersey, New Mexico, and Texas have all adopted an RPS. Pennsylvania included an RPS in restructuring settlements with distribution companies. Wisconsin enacted an RPS as part of electricity reliability legislation, without restructuring to allow retail competition. Iowa and Minnesota have enacted minimum renewable energy requirements for regulated utilities. Nevada recently revisited and significantly increased its RPS, raising the standard from 1% by 2009 to 15% by 2013.

The RPS programs vary substantially, but all require that the state's renewable share of total electricity be increased by using a range of eligible sources. Much of the expected growth in green power in the United States is attributed to these programs.

In 1999, the Texas government established an RPS within the state's electricity market. The Texas RPS requires electricity suppliers to source a minimum percentage of electricity from renewable sources with the aim of generating 2,000 MW of new renewable energy in Texas by 2009, with increasing interim requirements and individual utilities' shares assigned in proportion to their retail sales. The utilities may either generate the renewable electricity themselves or purchase credits from other generators with surplus renewable electricity supplies. Wind and landfill gas are expected to provide most of the renewable energy under the Texas RPS, but the selection of possible sources of renewable energy for the Texas plan also includes biomass, geothermal, hydroelectricity, and solar energy technologies. Even though these RPS obligations did not begin until 2002, the announcement in 1999 and the completion of implementing regulations have already propelled Texas to one of the largest renewable energy markets in the U.S. Several large wind facilities have already been announced or contracted since the program was announced. Short-term goals for 2003, and 2005 have already been met, years ahead of schedule.

Under New Jersey's RPS program, sales of green power must increase until 6.5 percent of each of the State's retail electricity providers' sales are supplied by green power by 2012. Any electricity provider falling below the renewable requirement would be required either to make it up in the next year or to purchase credits from another electricity provider with a surplus of green power. There is also a provision for generating units outside New Jersey to contribute to the renewable share. As in some other states, the law also defines two classes of renewable energy technology. The first, class one, includes photovoltaics, solar thermal electric, wind, geothermal, fuel cells, landfill gas recovery and sustainable biomass. Class two technologies are hydroelectric and waste-to-energy. Class two technologies can make up no more than 2.5% of a utility's total RPS obligation. Biomass and landfill gas projects are expected to account for the largest number of new green power projects, along with some new wind power projects.

Nevada has passed a green power bill that seeks to encourage development of wind farms, solar power plants and geothermal plants. The bill forces the state's utilities to gradually increase the amount of power they buy from renewable sources. In 2003, the regulated utilities

[33] National Renewable Energy Laboratory.
[34] Interstate Renewable Energy Council.

would be required to buy or generate 5% of their power from renewable sources, gradually increasing to 15% by 2013. At least 5% of the purchased power must be from solar.

Deregulation legislation in Connecticut calls for an RPS, which will require all providers to obtain an increasing share of their power from renewable energy sources. The Connecticut RPS begins at 0.75% in 2001 and ultimately rises to 4% in 2009.

The RPS in Pennsylvania is imposed on a service-territory basis. For PECO, West Penn, and PP&L, an RPS of 2% in 2001, increasing 0.5% per year, is applied to 20% of the residential customers; for GPU, an RPS of 0.2% for 20% of customers in 2001 and for 80% of customers in 2004. The following table sums up the requirements for each state's RPS.

Table 22: U.S. Renewable Portfolio Standards

State	Renewable Portfolio Standard	Eligible Technologies
Arizona	1% by 2005 1.1% by 2007	• 60% solar PV and solar thermal electric by 2007 • 40% solar hot water and in-state landfill gas, wind, and biomass
Connecticut	3% by 2006 6% by 2009	Solar, wind, hydro, sustainable biomass, landfill gas, fuel cells
Iowa	105 average MW Approximately 2% of 1999 sales by 2011	Solar, wind, methane recovery, biomass
Maine	30% of sales in 2000	Fuel cells, tidal power, solar, wind, geothermal, hydro, biomass
Massachusetts	4% by 2009 +1% per year thereafter until date determined by the Division of Energy Resources	Solar, wind, ocean, fuel cells using renewable fuels, landfill gas, and biomass
Minnesota	425 MW of wind by 2002 125 MW of biomass by 2002 400 MW more wind by 2012	Wind, biomass
Nevada	5% by 2003, growing biannually to 15% in 2013	• Solar, wind, geothermal, biomass • Minimum 5% of total green power sold each year must come from solar
New Jersey	1% by 2006 4% by 2012	Solar, wind, fuel cells, geothermal, ocean, landfill gas, sustainable biomass
New Mexico	5% of standard offer service by 2002, depending on in-state resource availability and 1 mill/kWh cost cap	In-state wind, solar, geothermal, biomass, hydro, fuel cells
Pennsylvania	• For PECO, West Penn, and PP&L, 20%	Non-hydro renewables

	of residential customers served by competitive default provider: 2% in 2001, increasing 0.5%/yr. • For GPU, 0.2% in 2001 for 20% of customers increasing to 80% in 2004	
Texas	1.65% or 1280 MW by 2003 2.15% or 1730 MW by 2005 2.75% or 2280 MW by 2007 3% or 2880 MW by 2009	Solar, wind, geothermal, hydro, ocean, biomass, landfill gas
Wisconsin	0.5% by 2001, increasing to 2.2% by 2011	Wind, solar, biomass, ocean, geothermal, fuel cells that use renewable fuel, hydro under 60 MW

Proposed laws for instituting an RPS are pending in Maryland, Nebraska, California, Washington and Oregon. Renewable goals have also been seen on the federal level in several pieces of electric restructuring legislation.

An RPS in California would enhance existing renewable energy investment programs in California by creating a reliable market for renewable power. Such a law would also work to hedge against natural gas price volatility, protecting consumers against increases in electricity rates and providing long term rate stability. California's recently passed RPS is by far the most aggressive and the most complex of all U.S. Standards. It requires all utilities and every other energy marketer in the state to provide 20% of their electricity from renewable sources by 2010. The bill leaves it up to the California Energy Commission to decide which green power technologies are eligible to be included in the RPS.

California has also enacted a renewable energy mandate with a funding requirement under California Assembly Bill 1890 (A.B. 1890). Under A.B. 1890, $162 million is to be collected from the ratepayers of investor-owned utilities. Renewable energy projects are proposed on a voluntary basis and bid for support on a per kWh incentive basis. A.B. 1890 projects are expected to include primarily wind, geothermal, and landfill gas.

New York State Gov. George E. Pataki has ordered state buildings to get at least 10% of their electric power from green power by 2005 and 20% of by 2010. The order applies to the state's buildings and those of quasi-independent agencies like the State University of New York and the Metropolitan Transportation Authority. The order also requires the state to adhere to strict energy efficiency standards when it constructs buildings or significantly renovates existing ones.

Minnesota recently adopted a new law that establishes annual targets for all utilities in the state to supply a small but growing percentage of their electricity from renewable energy resources, defined as wind, solar, biomass or low-impact hydro, culminating in 10% by 2015. In addition, the law requires all utilities in the state to offer green pricing programs. Though utilities are only required to "make a good faith effort" to meet the targets, they must report their progress to the Minnesota Public Utilities Commission under the state's resource planning provision, which has a strong preference for renewable resources. The Public Utilities Commission is authorized to establish a tradable credit program to facilitate compliance with this section.

State financial incentives also include personal income tax credits and deductions for the purchase of various renewable-based technologies; corporate income tax credits, exemptions, and deductions for investments in renewable technologies; sales tax exemptions on renewable equipment purchases; variable property tax exemptions on the value added by the renewable energy system; renewable technology and demonstration project grants; and special loan programs for renewable energy investments.

On the national level, an RPS was passed in the Senate in April that would provide 10% of U.S. electricity from wind, solar, geothermal, and biomass by 2020. However, the House energy bill passed last year doesn't contain an RPS and the two bills have not yet been reconciled. The bill is in a Senate-House conference committee to work out differences. In July, Spencer Abraham, the energy secretary, said the administration opposed the provision in the Senate version of the bill which would establish an RPS. Electricity producers also oppose the provision. Supporters of the bill hope then since this provision is modeled after Texas' RPS, which then-Governor George W. Bush signed into law, that President Bush will likewise sign this bill if it is passed.

PV Buy-Down Programs

There is also an initiative to expand the U.S.-based photovoltaic industry's manufacturing capacity to meet growing demand. Their long-term goal is to build a $15 billion industry by 2020. Within the next 18 years, the photovoltaic industry expects to employ more than 150,000 Americans in high-value, high-tech jobs. To support these efforts by the PV industry, state and federal government, will level the playing field so that solar electricity can compete with other power players. The Government will also lower the barriers that hinder PV technology from being developed and deployed.[35]

Each state participating in this type of program has a slightly different idea about the most effective means of providing support. Many states have implemented what are commonly know as "buy-down" programs, where funds are distributed as grants to subsidize or "buy-down" the initial cost of the system. Other funds have taken different approaches, soliciting proposals for specific projects, offering pre-development grants, developing infrastructure and distribution channels, or investing seed capital in budding PV manufacturers.

Several different states currently offer PV buy-downs. These are detailed in the following table.

[35] U.S. Department of Energy National Center for Photovoltaics.

Table 23: PV Buy-Down Programs

State	System Size Limit*	Buy-Down Level ($/W up to % of system cost)	Maximum Funding per System	System Requirements	Installation Requirements**	Warranty	Performance Guarantee	Grid Connect
CA	None Specified	$4.50/W up to 50%	$ 2,500,000	Must have appropriate UL listings	Contractor must hold appropriate licenses (though owner can install system without using a contractor)	Full 5-yr on entire system if installed by a licensed contractor, limited 5-yr if installed by owner	Warranty must protect against degradation in electrical output of >10% Random audits	Required
IL	0.5-2 kW	$6/W up to 60%	$5,000	UL-listed or 1 yr of field testing	None specified	None required	None, though system may be inspected	Not specified
	≥2 kW	$6/W up to 60%	$300,000					
NJ	≤10 kW	$5/W up to 60%	None	UL-listed	Must be installed such that output exceeds a minimum percentage of optimal output.	Full 5-yr on entire system	Program administrators will inspect 100% of the eligible installations in the first yr. prior to issuing the rebate incentive	Not required
	10-100 kW	$4/W up to 60%						
	>100 kW	$3/W up to 60%						
NY (LIPA)	≤10 kW	$6/W installed by 7/31/02 $4/W installed after 7/31/02	$60,000	None	None specified	None required	System may be inspected before rebate issued	Required

State	System Size Limit*	Buy-Down Level ($/W up to % of system cost)	Maximum Funding per System	System Requirements	Installation Requirements**	Warranty	Performance Guarantee	Grid Connect
PA (PECO)	1-5 kW	$3/W (owner) upfront $1/kWh (owner) after 1 yr. 10¢/kWh (installer) after 1 yr.	$6,000 $2,000 $250	Systems must be FSEC-approved or components must be CEC-approved, or else must meet a series of IEEE, UL, and other standards	Installers must be pre-certified System must be sited such that it can produce ≥70% of optimal output	Full parts and labor for 2 yrs, limited parts for additional 3 yrs.	1 yr. anniversary payment to owner and installer based on system performance	Preferred
RI	None Specified	$3/W up to 50%	None	None	None specified	None required	None	Not Specified

Source: Clean Energy Funds Network

*In addition to these limits, all programs require eligible customer-sited PV systems to be sized such that output does not exceed historic on-site load.
**In addition to meeting all applicable national, state, and local codes.

Funding Incentives For Green Power

The U.S. has a number of incentives -- rebates, grants, and tax credits -- that federal, state, and local governments offer that serve to reduce the cost of installing a green power system.

Federal Incentives

The federal government offers support for photovoltaic systems through a couple of different sources. First, the federal government offers a *Business Investment Tax Credit* for photovoltaic systems. Commercial entities can take a tax credit of up to 10% of the purchase and installation amount of solar property. The allowable tax credit for any given year is also limited to $25,000, plus 25% of the total tax remaining after the credit is taken. Another such tax credit is the *Renewable Electricity Production Credit (REPC)*, also called the *Wind Energy Production Tax Credit (PTC)*. This is a per kilowatt-hour tax credit for electricity generated by qualified energy resources - defined as wind, closed-loop biomass, or poultry waste. Available during the first 10 years of operation, the REPC provides a 1.5 cents per kWh credit adjusted annually for inflation. The adjusted credit amount for 2002 is 1.8 cents per kWh. Enacted as part of the Energy Policy Act of 1992, the credit, which had expired at the end of 2001, was extended in March 2002 as part of H.R. 3090, Job Creation and Worker Assistance Act of 2002. The credit is set to expire on 12/31/03.

Second, the federal government offers 5 year *Accelerated Capital Depreciation* for any commercial entity which invests in or purchases renewable energy systems. For example, the *Job Creation and Worker Assistance Act* of 2002 allows businesses to take an additional 30% depreciation on solar, wind, and geothermal property in the first year. The 30% depreciation only applies to property purchased after September 10, 2001 and before September 11, 2004, which is placed in service before January 1, 2005. This 30% depreciation is in addition to the depreciation deduction allowed for solar, wind, and geothermal property under the modified accelerated cost recovery system (MACRS). MACRS establishes a set of class lives for various types of property, ranging from three to 50 years, over which the property may be depreciated. For solar, wind, and geothermal property placed in service after 1986, the current property class is five years.

Third, the federal government offers *Energy Efficient Mortgages (EEM)* that can be used by homeowners to pay for energy efficiency measures for new and existing homes. EEMs are federally recognized and can be applied to most home mortgages. Both government insured (e.g., FHA, VA) and conventional (e.g., Fannie Mae) EEMs are available. All buyers who qualify for a home loan qualify for the EEM. The EEM is intended to give the buyer additional benefits on top of their usual mortgage deal. The lender will use the energy-efficiency of the house, as determined by a HERS rating, to determine what these benefits will be.[36]

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[36] "Federal Incentives for Renewable Energy." Database of State Incentives for Renewable Energy. 10 Oct. 2002.<http://www.dsireusa.org/dsire/library/includes/genericfederal.cfm?currentpageid=1&search=federal&state=federal>

State Incentives

There are a variety of state programs that serve to reduce the cost of implementing distributed generation. The following section lists the states that offer incentives and details the incentives that are applicable to commercial or industrial installation of such technologies.

Alabama

Renewable Fuels Program – Biomass

Alabama's Science, Technology, and Energy Division of the Department of Economic and Community Affairs offers interest subsidies on loans for the installation of qualifying biomass energy and waste fuel systems in commercial, industrial, agricultural, or institutional facilities. Qualifying projects include the installation of, or modifications to, equipment for the production of hot water, steam or hot air from biomass. Also eligible is equipment for biomass fuel storage, preparation, and transport, as well as equipment incidental to the production of biomass fuels. The maximum interest subsidy available to any one project is $75,000. A borrower obtains a loan from a commercial lending institution and applies to the Division for interest payment assistance. Assistance is given only for loans with interest rates no greater than 2% above the prime rate.

Alaska

Power Project Revolving Loan Fund

Created by the Alaska State Legislature and administered by the Alaska Energy Authority, this fund provides loans to local utilities, local governments, regional and village corporations, village councils, nonprofit marketing cooperatives, and independent power producers. It is designed for the development or upgrade of small-scale power production facilities, conservation facilities, and bulk fuel storage facilities. This includes energy production, transmission and distribution, and waste energy conservation facilities that depend on wind power, tidal, geothermal, biomass, hydroelectric, solar, or other non-nuclear energy sources. The loan term is related to the life of the project. Interest rates are the lesser of the average weekly yield of municipal bonds for the 12 months preceding the date of loan, or a rate the Division determines will allow the project to be financially feasible.

Arizona

Tucson Electric Power SunShare Program

Customer may either purchase a qualifying system 1 kW or larger from a third party or may purchase a 1 kW or 5 kW system kit from TEP. Under the third party option, TEP will pay the customer $2,000 per kW AC of installed solar generating capacity. Under the TEP kit option, TEP will pay the customer $2,000 for the 1 kW system and $10,000 for the 5 kW system. The kit includes panels, inverter, supports, meter, and meter socket. The cost for a 1 kW solar kit is approximately $9,000 plus installation costs. A kit purchased from TEP will cost less.

Solar and Wind Energy Systems Credit

Provides a credit against the personal income tax in the amount of 25% of the cost of a solar or wind energy device. The credit can be claimed in the year of installation and has a maximum allowable limit of $1,000. If the amount of the credit exceeds a taxpayer's liability in a certain year, the unused portion of the credit may be carried forward for up to five years.

Solar and Wind Equipment Sales Tax Exemption

This retail sales tax exemption applies to solar and wind energy equipment. This exemption is allowed on equipment up to $5,000.

Solar Partners Plus
Arizona Public Service (APS) offers customers who install photovoltaic systems the opportunity to sell the credits associated with the energy generated by these systems to APS. These energy credits will be used to meet APS Environmental Portfolio Standards (EPS) requirements. Through the EPS Credit Purchase Program, participating customers receive a one-time EPS Energy Purchase Credit of $2.00 per watt of DC electricity (based on the manufacturer's rating) for purchasing and installing a photovoltaic system capable of producing 5 kilowatts or less.

For grid-tied systems rated at 5 kW or less: customers must purchase a new photovoltaic solar system rated at 5 kW or less, installations must meet APS interconnection requirements, customers must sign an interconnection agreement with APS, the system must use UL-rated components and meet IEEE 929 specifications, a licensed contractor must install the system, the system generation must be metered separately and the kWh credits may, at APS' option, be recorded annually, the meter must be placed adjacent to the existing meter and marked "solar meter".

California
Direct Equipment Sales
Pioneers II program allows customers to purchase installed roof-mounted PV systems from the utility for less than $5,000. The Sacramento Municipality Utility District buys down about half the cost of the system, then provides a financed loan to cover the balance. The loan is repaid over a period of ten years at a financing rate of 9.5% for the 60 or 48 module systems and 10.5% for the 32 module system.

Property Tax Exemption for Solar Systems
Active solar energy systems installed between January 1, 1999 and January 1, 2006 are not subject to property taxes.

Emerging Renewables Buydown Program
Pays $4,500 per kilowatt or 50 percent off the system purchase price (whichever is less) on photovoltaics, small wind turbines (<10 kW), fuel cells, and solar thermal systems. This program is also only applicable to customers of PG&E, SDG&E, and SCE.

Solar Tax Credit
Purchasers can take a tax credit of up to 15 percent of the net purchase cost of a photovoltaic system (<200 kW) in the years 2001-2003. The credit will be reduced to half that amount for tax years 2004-2005, and will sunset on January 1, 2006.

California Property Tax Exemption for Solar Systems
Active solar energy systems installed between January 1, 1999 and January 1, 2006 are not subject to property taxes.

Green LA Solar Program
Provides a minimum rebate of $4.50 per watt for photovoltaic systems manufactured outside the City of Los Angeles, and a maximum of $6.00 per watt for those manufactured inside. The maximum payment per site is $1 million for commercial

customers. Developers may receive a maximum incentive payment of $1,000,000 a year.

Self-Generation Incentive Program
Provides cash incentives for customers of PG&E, SDG&E, and SCE to produce their own energy through "self-generation" of electricity. The incentive is in the form of a rebate with the amount determined by the technology used. The incentives include payments of $1 - $4.50/Watt depending on the technology used and will be funded at $138 million annually through 2004 (see table below).

Table 24: CA Self-Generation Incentive Program

Incentive category	Incentive offered	Maximum percentage of project cost	Minimum system size	Maximum system size	Eligible Technologies
Level 1	$4.50/W	50%	30 kW	1 MW	• Photovoltaics • Fuel cells operating on renewable fuel • Wind turbines
Level 2	$2.50/W	40%	None	1 MW	• Fuel cells operating on non-renewable fuel and utilizing sufficient waste heat recovery
Level 3	$1.00/W	30%	None	1 MW	• Microturbines and small gas turbines using waste heat recovery and meeting reliability criteria • Internal combustion engines using waste heat recovery and meeting reliability criteria

Palo Alto - PV Partners
PV Partners offers $4/Watt to Palo Alto Utility customers who install qualifying PV systems.

Anaheim Public Utilities -- PV Buydown Program
Through the Anaheim Advantage Residential PV Buydown Program, customers with qualifying PV systems of a minimum 300 watts in size and a maximum output not exceeding the electric needs of the electricity consumer, are eligible for a rebate of $5/watt.

Burbank Water and Power -- Residential Solar Support
Burbank Water & Power offers residential customers a rebate of $3 per watt for PV systems of up to two kilowatts, for a maximum incentive of $6,000. Business customers can get a rebate of $3 per watt for PV systems of up to three kW, for a maximum incentive of $9,000.

Glendale Water and Power – Solar Solutions at Home PV Rebate
Residential electric customers are eligible for a rebate for photovoltaic installations of $5 per watt of system generation capacity or 50% of the total cost of the system, whichever is less for systems up to 10,000 watts.

Pasadena Water and Power – Solar Power Installation Rebate
Residential electric customers are eligible for a rebate for photovoltaic installations of $5 per watt of system generation capacity or $10,000 based upon available funding.

Redding Electric – Vantage Renewable Energy Rebate Program
Residential electric customers are eligible for a rebate for photovoltaic installations of 50% of project cost up to a maximum of $15,000.

Renewable Energy Rebate for Customers of Publicly-Owned Utilities
The California Energy Commission is offering cash rebates to customers of publicly-owned electric utilities that purchase and install renewable electric generating systems. The systems eligible for the rebate include photovoltaics, solar thermal electric, small wind, and fuel cells using renewable energy. The rebate amount could equal up to half the cost of the system. The system must be purchased and installed after December 19, 2001. System capacity may not exceed 10 kW and the system must be grid-connected.

Connecticut
Local Option for Property Tax
The state of Connecticut allows municipalities the option of offering property tax exemptions for certain renewable energy systems. Such systems include solar space and water heating, photovoltaics, wind systems, and micro-hydro. Adoption of this exemption varies from one municipality to another, but typically the exemption applies to the total value of the qualifying renewable energy system and can be applied to commercial and industrial property.

Connecticut Housing Investment Fund
Energy Conservation Loans from $400 to $6,000 are available through the Connecticut Housing Investment Fund to owners of 1 - 4 family homes who meet established income limits for family size and location. These loans may be used for a variety of conservation improvements including solar water heat, active solar space heat, solar thermal electric, PV, wind, biomass, hydro, and geothermal electric.

Delaware
Energy Alternatives Rebate
Under the program, energy alternatives rebates are available for the installation of qualifying photovoltaic, solar water heating, wind turbine, and geothermal heat pump systems. The maximum rebate amounts are 35% for photovoltaic, solar water heating, and wind turbine systems.

Florida
Solar Energy Equipment Sales Tax Exemption
This retail sales tax exemption applies to solar energy equipment.

PV Rebate Program
The utility pays one-third of the cost of the system; the Florida Solar Energy Center (FSEC) pays one-third; and the homeowner pays one-third. Installation is free. At the

current system cost, participants pay approximately $0.75/watt. New installations will depend on new state-funded rebate programs. The systems are owned by the customer, and the energy produced is net metered back to the utility. The utility offers 2.4-kW and 1.2-kW packages.

Hawaii

Solar Energy System Credit

This corporate income tax credit allows a company a credit of 35% of the cost of equipment and installation of an active solar system. The credit is to be applied in the year in which the system is purchased and placed into use. This credit is available for systems installed for commercial or industrial use, and there is no maximum limit to the total amount of the credit. Tax credits that exceed the taxpayer's income tax liability may be used as credit against the taxpayer's income tax liability in subsequent years until exhausted.

Wind Energy System Credit

This income tax credit allows individuals and corporations a credit of 20% of the cost of equipment and installation of a residential or non-residential wind energy system. The credit is to be applied in the year in which the system is purchased and placed into use, and there is no limit to the total amount of the credit. Tax credits that exceed the taxpayer's income tax liability may be used as credit against the taxpayer's income tax liability in subsequent years until exhausted.

Idaho

Solar, Wind and Geothermal Deduction

This statute allows taxpayers an income tax deduction of 40% of the cost of a solar, wind or geothermal device used for heating or electricity generation. The maximum deduction in any one year is $5,000.

Low Interest Loans for Renewable Energy Resource Program

This low interest loan program, administered by the Energy Division of the Idaho Department of Water Resources, makes funds available at a 4% interest rate for active solar, photovoltaic, wind, geothermal, hydropower and biomass energy projects. The program also makes loans for energy conservation projects. In the commercial and industrial sectors there is no minimum loan amount but there is a maximum cap of $100,000. Loans are repaid in five (5) years or less.

Illinois

Special Assessment for Renewable Energy Systems

Allows for a special assessment of solar energy systems for property tax purposes. Solar equipment is valued at no more than a conventional energy system. Eligible equipment includes active and passive systems, as well as wind systems.

Renewable Energy Resources Program Rebates

The Department of Commerce and Community Affairs may provide up to a 60% rebate for PV systems with a maximum of $6/watt and $5,000.

Indiana

Renewable Energy Systems Exemption

There is a property tax exemption on solar water heating, active solar space heat, wind, hydro, geothermal electric and geothermal heat pumps.

Iowa

Local Option Special Assessment of Wind Energy Devices

This statute allows any city or county to assess wind energy conversion equipment at a special valuation for property tax purposes. Those local governments offering this special assessment must follow state guidelines. In the first assessment year, the wind energy conversion equipment is to be assessed at zero percent (0%) of its cost. For the second through sixth assessment years, the valuation of the property is to be a percent of its cost which increases by five percentage points each assessment year. For the seventh and succeeding assessment years, the valuation of the property is to be at thirty percent of its cost.

Iowa Property Tax Exemption for Solar Systems

When assessing property for tax purposes, assessors shall disregard any market value added by a solar energy system to a building for the first five full assessment years.

Wind Energy Equipment Sales Tax Exemption

This statute exempts from the state sales tax the total cost of wind energy equipment and all materials used to manufacture, install or construct wind energy systems.

Kansas

Renewable Energy Property Tax Exemption

This statute exempts renewable energy property from property taxes.

Maryland

Clean Energy Incentive Act

Provides Maryland sales tax exemptions or income tax credits when purchasing renewable resource energy systems. An individual or a corporation may claim a state income tax credit of 15% of the total installed cost of a photovoltaic system. The maximum credit is $2,000 for a PV system. The unused amount of the credit for any taxable year may not be carried over to any other taxable year.

Income Tax Credit for Green Buildings

This income tax credit applies to nonresidential and residential multifamily buildings of at least 20,000 square feet that are constructed or rehabilitated to meet criteria set forth by the US Green Building Council or other similar criteria. Credits apply to three types of alternative energy sources: photovoltaics, wind turbines and fuel cells. The tax credit amounts are as follows: 20% of the incremental cost for building-integrated photovoltaics; 25% of the incremental cost for non-building integrated photovoltaics; 30% of the costs, including installation, for a fuel cell; and 25% of the costs, including installation, for a wind turbine.

Local Option Property Tax Exclusion for Renewable

Allows counties to provide a credit against the corporate property tax for buildings equipped with a solar system. Counties determine the amount of the credit. Counties also determine the length of time that the credit may be available up to a maximum of three years.

Clean Energy Incentive Act

The Maryland Clean Energy Incentive Act provides Maryland sales tax exemptions or income tax credits on qualified purchases of renewable resource energy systems. An

individual or a corporation may claim a state income tax credit of 15% of the total installed cost of a photovoltaic system. The maximum credit is $2,000 for a PV system. The Act also provides for an income tax credit for the production of electricity from biomass. The credit is 0.85¢/kWh.

Residential Solar Rebates
A limited number of rebates is available to qualified applicants for the installation of residential, grid-tied PV systems. Size requirements and rebate amounts are: 500 watts to 999 watt systems can get a rebate of up to $1,600; 1000 watt systems and larger can get a rebate of up to $3,200. A 15% tax credit and net metering are also available for residents who install PV systems.

Massachusetts
Solar and Wind Power Systems Excise Tax Exemption
Exempts solar and wind energy systems from the corporate excise tax for the length of the system's depreciation period. The state excise tax in Massachusetts is applied at a rate of $7.00 per $1,000 of assessed valuation.

Alternative Energy and Energy Conservation Patent Exemption
Massachusetts offers both corporate and personal income tax deductions for any income received from the sale of or royalty income from a patent that is deemed beneficial for energy conservation or alternative energy development.

Renewable Energy State Income Tax Credit
This statute provides a 15% credit against the state income tax for the cost of a renewable energy system installed on an individual's primary residence. The maximum limit to the credit is $1,000. Eligible technologies include solar thermal, solar water and space heat, photovoltaics, wind, and hydro systems.

Renewable Energy Equipment Sales Tax Exemption
Solar and wind systems are exempt from Massachusetts state sales tax.

Minnesota
Wind and Photovoltaic Systems Property Tax Exemption
Excludes from property taxation the value added by photovoltaic and certain wind energy systems. This statute applies to the residential, commercial, and utility sectors. Wind systems rated less than 2 MW are completely exempt -- including support structures -- for the life of the system.

Wind and PV Sales Tax Exemptions
Energy efficient products, including photovoltaic devices and wind energy systems, are exempted from the state sales tax. The exemption is effective for sales and purchases made after July 31, 2001 and before August 1, 2005.

Wind Generation Incentive
From July 1999 to June 2005, Minnesota will offer a 1.5 cent per kWh payment for electricity generated from new wind energy projects less than 2 MW in capacity.

Agricultural Improvement Loan Program for Wind Energy
This low interest loan program, which is administered by the Department of Agriculture through the Rural Finance Authority, provides loans to farmers wind energy conversion equipment.

Value-Added Stock Loan Participation Program
This low-interest loan program, which is administered by the Department of Agriculture through the Rural Finance Authority is designed to help farmers buy into wind generation cooperatives.

PV Rebate Program
The Minnesota Department of Commerce administers a solar electric (PV) rebate program, funded by Xcel Energy, to buydown the up-front costs of grid-connected photovoltaic systems by $2,000/kW, up to $8,000/system.

Mississippi
Energy Investment Program
This program makes low-interest loans for a variety of renewable energy projects. Eligible technologies include photovoltaics, geothermal, and biomass.

Montana
System Investment Credit -- Alternative Energy Systems
Allows a 35% tax credit for an individual, corporation, partnership, or small business corporation which makes an investment of $5,000 or more in a commercial system or a net metering system that generates energy by means of an alternative renewable energy source. Alternative energy systems include solar, wind, geothermal, conversion of biomass, fuel cells that do not require hydrocarbon fuel, small hydroelectric generators producing less than 1 megawatt, or methane from solid waste.

Renewable Energy Systems Property Tax Exemption
Exempts from property taxation the value added by a qualified renewable energy source. Qualified equipment includes active and passive solar, wind, hydropower, solid waste, and the decomposition of organic wastes. Such equipment is exempt from taxation for a period of 10 years following installation. The value added exemption applies to systems with up to $100,000 in the case of a multifamily residential dwelling or a nonresidential structure.

Residential Alternative Energy System Tax Credit
Residential taxpayers who install an energy system using PV, wind, biomass, or geothermal heat pumps on their home after 12/31/01 are eligible for a tax credit equal to the amount of the cost of the system and installation of the system, not to exceed $500.

Residential Geothermal Systems Credit
This statute allows residents to claim an income tax credit of up to $1,500 for the installation cost of a geothermal energy system in their principal dwelling.

Alternative Energy Revolving Loan Account
The alternative energy revolving loan account provides loans to individuals and small businesses for the purpose of building alternative energy systems for residences and small businesses to generate energy for their own use and for net metering. The amount

of a loan may not exceed $10,000, must be at a low interest rate, and the loan must be repaid within 5 years.

Nevada

Renewable Energy Systems Property Tax Exemption

Any value added by a qualified renewable energy source shall be subtracted from the assessed value of any residential, commercial or industrial building for property tax purposes. Qualified equipment includes solar, wind, geothermal, solid waste converters and hydropower systems. This exemption applies for all years following installation.

Renewable Energy Producers Property Tax Exemption

A allows a property tax exemption for any business that includes a facility for the generation of electricity from recycled material, whose primary purpose is the conservation of energy or the substitution of other sources of energy for fossil sources of energy. The exemption applies to 50% of the business property -- personal and real -- for up to ten years. If a facility is generating electricity from renewable energy, then it uses renewable energy as its primary source of energy, and has a generating capacity of at least 10 kW. Facilities located on residential property are not included. Renewable energy means biomass, solar energy, or wind.

Renewable Energy Sales Tax Exemption

The sales tax rate for any sales, storage, consumption or use of products or systems designed or adapted to use renewable energy to generate electricity and all of its integral components is 2% in all counties for those purchases made from January 1, 2002 through June 30, 2003.

New Jersey

Solar and Wind Energy Systems Sales Tax Exemption

New Jersey offers a full exemption from the state 6% sales tax for all solar and wind equipment. This exemption is available to all taxpayers.

Clean Energy Rebate Program

Offers rebates on eligible customer-sited renewable energy systems. Eligible technologies include fuel cells, photovoltaic, small wind, or sustainable biomass technologies. Systems under 10 kW can get a $5.00 per watt rebate, systems between 10 and 100 kW a $4.00 per watt rebate, and systems over 100 kW a $3.00 per watt rebate. The maximum rebate can not exceed 60% of system costs.

New Mexico

Renewable Energy Production Tax Credit

The Renewable Energy Production Tax credits provides a tax credit against the corporate income tax of one cent per kilowatt-hour for companies that generate electricity from wind power or solar energy. The credit is applicable only to the first 400,000 megawatt-hours of electricity in each of 10 consecutive years.

New York

Green Building Tax Credit Program

Offers tax credits to large commercial or multi-family residential "green" building owners and tenant spaces within green buildings that increase energy efficiency, improve indoor air quality and reduce environmental impacts. Projects can qualify for credits under six different program components: 1) *Whole Building Credit* (owner or tenant) where base

building and all tenant space are green; 2) *Base Building Credit* (owner) for non-dwelling spaces; 3) *Tenant Space Credit* (owner or tenant) where the base building must be green to qualify if the tenant space is under 10,000 sf.; 4) *Fuel Cell Credit* for systems fueled by a "qualifying alternate energy source"; 5) *Photovoltaic Module Credit*; and 6) *Green Refrigerant Credit* new air conditioning equipment using an EPA-approved non-ozone depleting refrigerant. The components 4, 5 and 6 have to be serving green spaces. The fuel cell credit is for 30% of capitalized cost of each fuel cell (6% x 5 years) with a cap of $1,000/kW x DC-rated capacity. The photovoltaic credit is for 100% of the incremental cost of "building-integrated" photovoltaic modules (20% x 5 years) or 25% of the incremental cost of non-building integrated photovoltaic modules (5% x 5 years) with a cap of $3/w x DC-rated capacity.

Solar Electric Generating Equipment Tax Credit
This personal income tax credit applies to expenditures on solar electric equipment used on residential property. Qualified expenditures are capped at $6.00/watt of rated capacity.

Solar and Wind Energy Systems Property Tax Exemption
Section 487 of the New York State Real Property Tax Law provides a 15-year real property tax exemption for solar and wind energy systems constructed in New York State.

Energy $mart Loan
The New York Energy $mart[SM] Loan program provides reduced-interest loans through participating lenders to finance renovation or construction projects that improve a facility's energy efficiency or incorporate renewable energy systems, including PV and wind systems.

North Carolina
Renewables Tax Credit
Provides for a tax credit of 35% of the cost of renewable energy property constructed, purchased, or leased by a taxpayer and placed into service in North Carolina during the taxable year. The credit is subject to various ceilings depending on whether the renewable energy equipment serves nonresidential property or residential property and, for residential property, the kind of renewable energy technology being used. The credit limit is $250,000 for all solar, wind, hydro and biomass applications on commercial and industrial facilities, including photovoltaic, daylighting, solar hot water, and space heating technologies. Renewable energy equipment costs eligible for the tax credit include the cost of the equipment and associated design, construction costs, and installation costs less any discounts, rebates, advertising, installation assistance credits, name referral allowances, or other similar reductions. The credit can be taken against franchise tax, income tax or, if the taxpayer is an insurance company, against the gross premiums tax. The allowable credit cannot exceed 50% of the taxpayer's tax liability for the year reduced by the sum of all other credits. The unused portion of the credit may be carried over for the next five succeeding years.

North Dakota
Geothermal, Solar, and Wind Income Tax Credit
Income tax credit of 3% per year for five years for the cost of equipment and installation of a geothermal, solar, or wind energy device.

Geothermal, Solar, and Wind Property Tax Exemption
Exempts from local property taxes any solar, wind, or geothermal energy device. This exemption is applied only during the five year period following installation.

Large Wind Property Tax Incentive
Reduces property taxes by 70% for wind facilities of 100 kW or larger. To be eligible, construction must begin by January 1, 2011.

Large Wind Sales Tax Exemption
Eliminates sales tax for wind facilities of 100 kW or larger. To be eligible, construction must begin by January 1, 2011.

Ohio
Conversion Facilities Corporate Tax Exemption
Exempts certain equipment from property taxation, the state sales and use tax, as well as the state franchise tax where applicable. It applies to tangible property used in energy conversion, thermal efficiency improvements and solid waste energy conversion. Generally, "conversion" refers to the replacement of fossil fuel sources of energy with alternative fuels or technologies; "thermal efficiency improvements" refers to the recovery of waste heat or steam produced in any commercial or industrial processes; and "solid waste conversion" refers to the use of waste to produce energy AND the utilization of such energy. Technologies included are solar thermal systems, photovoltaic systems, wind, biomass, and waste recovery systems.

Renewable Energy Loans
The Fund was created to provide an incentive for purchasing and implementing energy-efficient and renewable energy projects. It reduces the interest rate--by approximately half--on standard bank loans for those qualifying Ohio residents and businesses that borrow money to implement energy efficiency or renewable energy projects. Eligible projects include the purchase and installation of PV cells, wind turbines, and bio-mass.

Oklahoma
Zero-Emission Facilities Production Tax Credit
Starting January 1, 2002, an income tax credit is available to producers of electric power using renewable energy resources from a zero emission facility located in Oklahoma. The zero-emission facility must have a rated production capacity of fifty megawatts (50 MW) or greater. Renewable energy resources include wind, moving water, sun, and geothermal energy.

Oregon
Business Energy Tax Credit
Applies to investments in energy conservation and renewable energy resources. Photovoltaic systems, wind turbines, and biomass-supported fuel cells and microturbines are eligible for the credit. Renewable resource projects must replace at least 10 percent of the electricity, gas or oil used. The energy can be used on site or sold. The tax credit is for 35 percent of eligible project costs. 10 percent of the credit is taken in the first and second years and 5 percent each year thereafter. Customers can also allow the utility to claim the tax credit and instead receive a one-time, "pass-through" cash payment of about 28 percent of eligible costs.

Renewable Energy Systems Property Tax Exemption
The added value to any property from the installation of a qualifying renewable energy system not be included in the assessment of the property's value for property tax purposes. Qualifying renewables include solar, geothermal, wind, water or methane gas systems for heating, cooling, or generating electricity. This exemption is intended for end users and does not apply to property owned by anyone directly or indirectly involved in the energy industry.

Residential Energy Tax Credit
Homeowners and renters who pay Oregon income taxes are eligible for the Residential Energy Tax Credit if they purchase photovoltaics or wind. Photovoltaic systems are eligible for $3 per peak watt, up to $1,500. Wind systems are eligible for a credit of 60 cents per kWh saved during the first year, up to $1,500.

Photovoltaic Electricity Production Incentive for Environmental Attributes
The Bonneville Environmental Foundation and the Northwest Renewable Energy Cooperative have joined together to help reduce the costs of small residential and commercial photovoltaic systems in parts of Oregon and Washington. NWREC will sign 3-year agreements with the owners of new photovoltaic systems and pay them 10¢ per kWh for the Green Tags produced by the solar systems. BEF will then purchase the Green Tags from NWREC and sell them to its wholesale customers and on its website.

Small Scale Energy Loan Program
The Oregon Small Scale Energy Loan Program is administered by the Oregon Office of Energy. The funding source is unlike most other state renewable energy loan programs, which are funded by revolving funds. The sale of bonds is made on a periodic basis and, occasionally, to accommodate a particularly large loan request. Loans are available to individuals, businesses, schools, cities, counties, special districts, state and federal agencies, public corporations, cooperatives, tribes, and non-profits. Though there is no legal maximum loan, the largest single loan has been $16.8 million.

Rhode Island
Renewable Energy Personal Tax Credit
Eligible technologies for Rhode Island's renewable energy tax credit include photovoltaics, solar hot water and space heating systems, and wind systems. The tax credit declines over time as follows: 25% of the cost of the system for systems claimed in year 2000; 20% in 2001; 15% in 2002; 10% in 2003; and 5% in 2004.

Renewable Energy Property Tax Credit
States that renewable energy systems cannot be assessed at more than the value of a conventional heating, hot water, or other energy production system. Qualifying technologies include photovoltaics, solar hot water systems, and active solar space heating system.

Renewable Energy Sales Tax Credit
Offers a sales tax refund for qualifying renewable energy systems. Eligible technologies include photovoltaics, solar hot water, solar space heating, and wind systems.

PV & Wind Rebate Program
A $3 per watt buy-down up to 50% of the system cost is available to the state's residents, businesses and industries for the installation of photovoltaic systems. Similarly, a buy-down program of $1.50 per watt up to 50% of the system cost for wind generators of less than 10kW capacity is available.

South Dakota
Renewable Energy Systems Property Tax Exemption
Exempts from local property taxes renewable energy systems on residential and commercial property. The exemption applies to the entire assessed value of residential systems and 50% of the installed cost of commercial systems, and it may be taken for three years after installation. This exemption is not allowed for systems which produce energy for resale.

Texas
Solar Energy Device Franchise Tax Deduction
This statute allows a corporation to deduct the cost of a solar energy device in one of two ways: (1) the total cost of the system may be deducted from the company's taxable capital; or, (2) 10% of the system's cost may be deducted from the company's income. The franchise tax is Texas's equivalent to a corporate tax. Both taxable capital and a company's income are taxed under the franchise tax.

Solar and Wind-Powered Energy Systems Property Tax Exemption
Exempts taxpayers from any value added by a qualified renewable energy source for property tax purposes. Qualified equipment includes any active solar equipment and any wind devices, as well as transmission equipment.

Utah
Renewable Energy Systems Tax Credit
Provides a corporate income tax credit for renewable energy systems applies to 10% of the cost of installation of a system up to $50,000. Eligible technologies include active and passive solar systems, photovoltaics, biomass, hydropower, and wind. For residential buildings owned by the business, the credit is 25% of the cost of installation of a system up to a maximum credit of $2,000 per system. For commercial systems, the credit is 10% of the cost of installation up to $50,000. This tax credit expires on December 31, 2006.

Vermont
Local Option for Property Tax Exemption
Allows municipalities the option of offering property tax exemptions for certain renewable energy systems. Such systems include, "but not be limited to grist mills, windmills, facilities for the collection of solar energy or the conversion of organic matter to methane, and all component parts thereof including land upon which the facility is located, not to exceed one-half acre."

Sales Tax Exemption for Net Metering Equipment
All equipment purchased to construct and install a net metered renewable energy system is exempt from the state's 5% sales tax.

Virginia
Local Option Property Tax Exemption for Solar